Journal of Chemical Education

Published by
Section of Chemical Education of The American Chemical Society
Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924.

Vol. II **January, 1925** **No. 1**

CONTENTS

Page

Editor's Outlook ... 2
Report of the Commiteee on Prize Essays of the American Chemical Society 1923–1924. H. E. Howe, Chairman ... 3
The Relation of Chemistry to the Development of the Industries and Resources of California. Eugene Brownscombe ... 11
The Relation of Chemistry to Agriculture and Forestry. Oliver C. Pittman ... 17
The Relation of Chemistry to the Home. Benjamin Nassau ... 22
The Relation of Chemistry to National Defense. Elton R. Allison ... 27
The Relation of Chemistry to Health and Disease. Donald L. Vivian ... 32
The Relation of Chemistry to the Enrichment of Life. James Cole Reid ... 38
Prize Essay State Chairmen for 1925 ... 41
Chemistry in the French Lycées. William Foster ... 43
Report of Committee of Chemical Education of the American Chemical Society. Neil E. Gordon, Chairman ... 46
The Founders of Chemistry in America. Lyman C. Newell ... 48
The Objectives of High School Chemistry. J. O. Frank ... 53
The Cinderella of the Metals. M. Elizabeth Farson ... 57
Chemical Research in National Preparedness. Henry B. Faber ... 61
Helping the Metric Campaign. Eugene C. Bingham ... 62
Importance of Teaching Chemistry. Charles E. Munroe ... 67
A Coöperative Plan in Chemical Education. Neil E. Gordon ... 72

Chemical Digest:

1924 in Retrospect. D. H. Killeffer ... 74
Abstracts ... 81

Noise of Electrons Heard by Human Ears
Germans Again Claim to Make Gold from Mercury
Missing Chemical Element Located by One Faint Clew
The Race of the Rare Earths
European Chemist finds Substitute for Platinum
Air is Blue
Claims Resins were Origin of Diamonds
High School Chemistry and the Periodic System
The Alchemist
High School Science Teachers. A Study of Their Training in Relation to the Subjects They are Teaching
Photosynthesis
Supervised Study in Natural Science
New Chemistry Building at the University of Saskatchewan
On Buying Laboratory Supplies
Opportunities for Science Teachers in New York High Schools
The Astronomy of the Atom
Science Teaching in a Democracy
Public Education in Poland
Fifty Years of Chemistry in America
The Making of a Compleat Chemyst
College Placement Examinations
Trend of Developments in the Nitrogen Problem
Measurements of the Results of the Teaching of Chemistry

Chemistry Cross-Word Puzzle. Kenneth D. Beardsley ... 90
Local Activities and Opportunities ... 91
Recent Books ... 95

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS
LIBRARY

Gift of
Prof. Philip Mason
March, 1933
Bound May, 1933

EDITOR'S OUTLOOK

Were I asked what single scientific project in our high school curriculum was meaning the most for the future health, safety and prosperity of our boys and girls, there could be but one answer, namely, the National A. C. S. Prize Essay Contest. At first thought you may think this exaggerated, but pause a moment. Do you know that during the past year 500,000 high school pupils took part in this contest, and it is anticipated that a far greater number will participate during this present year? When this great array of youth has become educated to the vital role chemistry plays in developing the health, safety, and prosperity of our country, do you think they will forget it when they grow into manhood and womanhood? No! Emphatically, no!

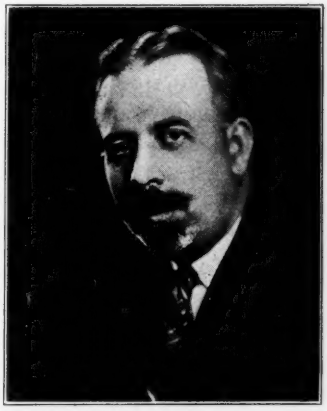
Some will be inspired to push out on the chemical frontier and try to make this country a safer and happier place in which to live, others will give freely of their means to promote chemical work, while all will ever have a friendly eye to the development of our great creative science—chemistry. An enlightened public leads to action. The A. C. S. contest is simply opening the minds of the rising generation to the potentialities in chemistry and when this rising generation has reached the stage of public participation, there will be developed a civilization unparalleled in health, safety, and prosperity

A8378

QD
1
F24
v. 2

REPORT OF THE COMMITTEE ON PRIZE ESSAYS OF THE AMERICAN CHEMICAL SOCIETY, 1923-1924

During the school year, 1923–1924, the American Chemical Society conducted its first prize essay contest for students in the high and secondary schools of the United States. The committee in charge offers this detailed report for the use of educators and others concerned with educational progress in America, as well as for the benefit of the many who have inquired regarding the genesis of the contest, its ideals, and scope.



Harrison E. Howe
Chairman of the National Prize Essay Contest of the A. C. S. Editor, Industrial and Engineering Chemistry, Washington, D. C.

At the Council meeting of the American Chemical Society held in New Haven, Connecticut, in the spring of 1923, it was indicated that Mr. and Mrs. Francis P. Garvan, of New York, would provide funds for a National Contest among high and secondary school pupils, and that if this project met with the approval of the Council and the Society, full details would be announced during the autumn meeting to be held at Milwaukee, Wisconsin, in September, 1923. At the September meeting the Society accepted the gift of Mr. and Mrs. Garvan, which was made as a memorial to their daughter Patricia, and a committee was appointed to organize and carry forward the work.

In the letter conveying his gift to the Society, Mr. Garvan stated that the purpose of the contest was to arouse in the youth of our country an intelligent appreciation of the vital relationship of the development of chemistry to our national defense, to the development of industry and our natural resources, to agriculture and forestry, to health and disease, to the home, and to the enrichment of life. The contest, therefore, was a purely educational project, endorsed and undertaken as an integral part of the activities of a long-established national scientific society. From the very beginning the aid and coöperation of the educational authorities and established organizations were solicited and an effort was made to correlate the work of the contest with that of our school system, that the contest might accomplish most as a stimulant in carrying forward existing educational activities.

That this motive was recognized and appreciated is evidenced by the endorsement as well as the active support of educators and educational institutions. It must be borne in mind that no specified industry or

group of industries could benefit by the contest, the objective being to promote a nation-wide understanding of the accomplishments of science, past and present, and its importance in the modern world, and to arouse appreciation and understanding of the possibilities of more intensified scientific investigation.

The contest did not seek to add materially to the numbers of those engaged in chemistry as a profession, nor was it designed to lay undue stress upon chemistry as a science. It was hoped to encourage students to know more about chemistry without necessarily engaging upon the serious study of the science itself, to realize the cultural value of such study, and with this introduction to become interested in a fuller acquaintance with other natural sciences. Prizes were, therefore, offered as a stimulus, the quality of the essays being a criterion of the students' interest.

The gift stipulated that a first prize of twenty dollars in gold would be given for the best essay in each of six subjects in each state and the District of Columbia, and that from the winners of these prizes six were to be chosen, one in each subject group, as national winners. These were to be awarded four-year scholarships at Yale or Vassar, these scholarships paying tuition and five hundred dollars annually for four years.

The Society's committee, therefore, communicated with as many state superintendents of education, school principals, and teachers of science as was possible, utilizing existing lists and whatever means were at hand, so that none would be overlooked. There were 463 state educational officials, not including county superintendents or officials of lesser rank, 12,904 principals of schools and colleges, and 6841 science teachers who received communications from the committee. In addition many were seen personally by members of the committee or by state committees and coöperating chemists. Colored posters announcing the contest were distributed to the number of 12,796, together with 111,106 booklets describing the contest in detail.

Simultaneously with this announcement of the contest, in which the aid of the daily newspapers was solicited in addition to the literature above mentioned, steps were taken to provide for the judging of the essays upon their completion. The aid of local sections of the American Chemical Society and other interested groups was sought in the formation of state committees of award, upon which we were most fortunate in securing the services of prominent men and women from all walks of life. Frequently school authorities carefully examined the work of their pupils and entered for final judgment only those essays which they felt should be submitted. In many cases local chemists and others competent to judge assisted in selecting the best of the essays as a guide to the state committees in making their final awards. In other instances the state committees preferred to undertake all the work involved, this being the case

especially in those states where the number of essays, after consideration by the school authorities, was not great.

In judging essays winning first places in the states and therefore entered in the national contest, the Division of Chemical Education of the American Chemical Society rendered conspicuous service. Committees of this division took the 49 essays in each group and from them selected the three best which in turn were submitted to the national committee. This committee made the final award of the six scholarships. It so happened that of the six boys who were the national winners, only one was able to qualify for entrance to Yale in the autumn of 1924, four of the boys having another year of high school to complete, and the sixth, lacking sufficient credits in modern languages to enable him to enter, is now making up that deficiency. The scholarships are consequently being held for one year with the expectation that these boys will be qualified to take advantage of the award in the autumn of 1925. Four girls and two boys won second places in the contest.

The winning essays came from the states of Arizona, California, Connecticut, Georgia, Texas and Washington. As the statistics show, one of the states submitting a small number of essays nevertheless produced a national prize winner, and centers which because of library facilities and outstanding examples of chemistry in service might be expected to give pupils an advantage, did not succeed in the 1923–1924 contest in producing national winners.

As the contest was designed to interest the nontechnical student as well as those interested in the study of chemistry itself, the committee prepared a reading list of books comprehensible to the layman and sound from the point of view of the scientist. A more substantial service was rendered by the actual distribution of sets of five books, made possible through the coöperation of The Chemical Foundation, Inc., and the several publishers. Of these sets, 12,541 were donated to schools and 654 to libraries. In addition, 3551 sets of books were donated to individuals interested in education, and nearly ten thousand more were sold at the actual cost of printing and distribution to many individuals. These included nearly two thousand members of the American Chemical Society who saw an opportunity to acquire these excellent volumes for their own libraries or to use them in an effort, which has been nation-wide, to acquaint the nontechnical reading public with the service which chemistry renders. The committee also received many requests for sets from universities and colleges. The books distributed were: "Creative Chemistry," by Edwin E. Slosson, "The Life of Pasteur," by Vallery-Radot, "The Riddle of the Rhine," by Victor Lefebure, "Discovery, The Spirit and Service of Science," by R. A. Gregory, and "The Future Independence

and Progress of American Medicine in the Age of Chemistry," by a Committee of American Scientists.

The libraries coöperated most effectively in carrying out the purposes of the contest. Correspondence shows that the books donated were extensively used both in the libraries and by intensive circulation. Some libraries made a special effort to build up that section of their books dealing with applied chemistry and report an extension of reading of the works on hand dealing with useful arts. An increased desire to consult and utilize useful and constructive books on the part of contestants was everywhere apparent and in some cases both teachers and parents have expressed great satisfaction with this unexpected benefit of the contest.

No less effective was the coöperation of many institutions of higher learning. The following educational institutions, inspired by the example set, offered scholarships, some of them as many as six, to students winning state prizes: Baylor College for Women, Catholic University of America, Georgetown University, Northern Normal and Industrial School, Northwestern University, St. Louis University, State University of Iowa, University of Arizona, University of Florida, University of Kentucky, University of Maryland, University of Mississippi, University of Missouri, University of Virginia, Washington and Lee University.

In several instances the university extension departments saw in the contest an opportunity to further their work which they were quick to appreciate and utilize.

In many schools the most enthusiastic supporters of the contest were the teachers of English, and, indeed, the number of pupils in English classes was very often the key to the number of essays that might be expected from a given institution. This bears out the assertion frequently made that special technical knowledge is not essential to success in the contest. This was apparently not well understood, for the questionnaires show several cases where large numbers of essays were written but not submitted because the teachers believed that the essays must be prepared by students in chemistry. There was one case where 144 such essays were prepared but none submitted.

In connection with the contest many local sections of the American Chemical Society arranged series of popular lectures which were given in local schools and also obtained the coöperation of broadcasting stations, making possible a series of short radio talks on these several topics. Through this means and through the interest of contestants, it is certain that a general interest in the subject of chemistry was engendered among parents, school officials and civic bodies. The increased demand upon publishers for well-written and popular books on science subjects is one result of this movement, and the publishers have shown themselves alive to this new demand. The continued coöperation between the teachers

of English and Science may be expected to yield still further beneficial results in a general educational way.

One of the first difficulties which confronted the committee was inadequacy of the list of teachers and the lack of a proper classification for high and secondary schools. The committee had to make several arbitrary rulings involving such questions as: What is a high school? And a secondary school? What place do the junior college, the academy, and the normal school occupy in the plan? And what is an acceptable definition of a college and a university? The specifications of the Bureau of Education of the Department of the Interior were not found applicable in all cases, and frequently the committee had to be guided by the classifications employed in the individual states. This same difficulty may confront the committee during the continuation of the contest, but it is hoped that standards may be developed by educators which will assist in all such instances. As for the list of teachers, a great deal of time, effort, and money has been spent in perfecting the list and it is believed that there is now in the possession of the committee a list, which, because of its completeness and accuracy, is of great value. For the 1924–1925 contest, 2874 new schools have been added, and had the committee been guided solely by lists available in 1923–1924, a very large number of schools whose students were eligible to compete would have been overlooked.

Through the fine coöperative spirit that has been shown by many school principals, teachers and librarians, in reporting on the progress of the contest and answering questionnaires concerning it, the committee has been kept informed of the chief difficulties that very naturally presented themselves in this first year of its operation. It has been reported that in some cases there was found some lack of correlation between various school officials and between departments within the school where matters of general interest were concerned. Owing to administrative pressure, information regarding the contest that reached the principal was sometimes not passed on by him to the teacher or the students. In some instances we are told that the teachers did not fully inform the principal or other school officials regarding the contest. In other cases the school libraries are said to have failed to assist the Science and English departments, and in still others these departments apparently did not meet the friendly advances of the librarian in a way that might be expected.

Still another difficulty lay quite naturally in the lack of uniformity in scientific courses. Some schools offer only chemistry, others only physics, and a certain number alternate between chemistry and physics courses, while still others teach neither science. It is interesting to learn how frequently teachers who may be employed to instruct in mathematics, for example, suddenly find themselves called upon to teach what-

State	No. schools with which committee corresponded	Schools sent books	Number questionnaires returned	Essays written by students	Essays submitted by schools	Essays received by State committee	Students known to have read books	Schools teaching chemistry only	Schools teaching physics only	Schools offering both sciences	Schools alternating chemistry and physics courses	Schools offering neither science	Enrollment in schools reporting	State
Ala.	192	184	55	156	37	63	474	1	5	45	0	2	10,417	Ala.
Ariz.	38	35	24	577	59	60	934	2	1	20	0	0	6670	Ariz.
Ark.	113	107	33	78	31	54	331	2	12	17	0	0	9163	Ark.
Calif.	349	333	154	899	262	325	2774	15	3	119	6	2	79,283	Calif.
Colo.	121	117	76	384	117	118	1112	1	2	55	3	0	16,588	Colo.
Conn.	149	137	72	447	128	147	953	2	7	40	3	6	26,607	Conn.
Del.	34	33	22	45	37	109	185	4	2	5	1	2	1668	Del.
Fla.	126	122	41	349	123	129	485	3	7	30	0	3	6789	Fla.
Ga.	264	261	78	262	62	63	570	5	13	29	2	9	11,185	Ga.
Ida.	78	77	44	210	71	80	559	4	4	21	2	2	8435	Ida.
Ill.	739	726	304	1244	447	449	3454	4	117	146	3	4	86,384	Ill.
Ind.	678	660	231	803	146	149	2938	5	102	56	9	12	49,937	Ind.
Ia.	708	696	247	678	240	253	3239	3	159	34	4	3	37,518	Ia.
Kan.	164	159	101	425	155	155	1815	2	27	40	4	2	25,338	Kan.
Ky.	155	153	52	194	83	87	419	5	5	29	0	3	12,741	Ky.
La.	239	237	71	222	91	100	407	19	10	18	4	3	5254	La.
Me.	231	222	91	311	69	70	1019	4	0	66	6	2	11,535	Me.
Md.	173	155	81	288	123	131	784	8	11	36	5	4	13,531	Md.
Mass.	367	346	182	739	207	243	2255	3	7	122	11	4	64,910	Mass.
Mich.	381	377	176	1147	264	270	3272	1	3	135	10	2	55,321	Mich.
Minn.	299	294	166	1270	368	392	2697	12	3	121	9	0	37,976	Minn.
Miss.	165	163	48	155	68	92	407	5	9	17	1	7	6849	Miss.
Mo.	407	393	141	506	142	145	2354	8	18	38	3	16	40,358	Mo.
Mont.	122	121	52	435	79	80	805	3	6	19	11	7	7893	Mont.

Nebr.	161	156	71	136	76	78	645	3	20	33	4	1	20,440	Nebr.
Nev.	24	24	16	201	26	27	271	1	2	9	1	2	2034	Nev.
N. H.	136	131	67	163	85	93	656	3	3	38	8	8	10,984	N. H.
N. J.	241	234	121	508	142	200	1711	3	1	86	6	3	53,803	N. J.
N. M.	28	28	11	46	18	19	141	1	1	7	1	1	2249	N. M.
N. Y.	702	691	355	1070	382	410	5175	10	10	201	31	6	161,845	N. Y.
N. C.	221	218	68	289	98	106	964	8	9	29	3	7	12,884	N. C.
N. D.	90	90	36	69	26	38	373	4	3	23	0	2	5895	N. D.
O.	557	554	347	1157	426	435	4393	1	82	188	23	3	101,722	O.
Okla.	317	312	72	274	90	91	1573	3	23	20	0	17	30,896	Okla.
Ore.	241	238	112	333	92	127	1267	4	29	37	6	27	16,344	Ore.
Pa.	658	649	281	1749	404	448	8222	9	20	234	16	4	104,418	Pa.
R. I.	37	37	21	81	29	37	319	0	0	17	0	1	10,176	R. I.
S. C.	86	84	29	98	27	36	421	0	2	15	0	6	5860	S. C.
S. D.	153	147	74	277	84	102	1103	5	31	20	2	1	7737	S. D.
Tenn.	126	122	41	99	51	113	456	5	2	25	0	1	8254	Tenn.
Tex.	311	309	124	597	148	154	2052	4	12	64	2	3	37,884	Tex.
Utah	64	64	41	449	82	92	1300	0	2	18	2	2	9221	Utah
Vt.	93	92	61	197	77	98	544	4	4	36	2	0	7427	Vt.
Va.	383	380	154	633	190	193	1558	61	15	38	1	24	22,008	Va.
Wash.	208	207	114	424	113	138	3001	5	20	59	10	0	27,253	Wash.
W. Va.	145	143	86	213	80	103	965	17	4	35	10	10	17,662	W. Va.
Wis.	381	377	198	1402	298	300	7012	2	77	82	0	3	46,857	Wis.
Wyo.	62	61	39	181	38	42	450	6	8	11	1	6	5436	Wyo.
D. C.	41	39	18	61	32	100	425	3	0	9	0	2	9397	D. C.
	11,758	11,495	5099	22,531	6523	7344	79,239	283	913	2592	226	235	1,371,036	

ever chemistry, physics, biology, geology, etc. may be offered. Fortunately the day is passing when such an attitude typifies any but a small minority, but there are apparently still some school officials who may fail to recognize that in these days of specialties one cannot expect a teacher to give adequate instruction in a wide variety of courses, especially those involving science.

It was also indicated that the coöperation between city libraries and schools offers a field for worth while development. It seems clear that each may be of service to the other without in any way impairing the service which such libraries render to the citizens at large. It is becoming recognized that libraries should include the more popular scientific works in their regular lists of books for the reading public.

The demand for better chemical courses which has arisen in some of the high schools is in many cases credited to the Prize Essay Contest and a few instances are known where laboratories are being installed in high schools directly as a result of the interest aroused by the contest. Many letters on file from teachers and officials indicate that the spirit of the contest was immediately caught, that the teachers recognized the help which the contest could give them, and that regardless of success in winning state or national prizes, it was realized that whole-hearted participation in the work involved in the contest would in itself fully repay the time and effort required.

In the booklet announcing the 1924–1925 contest the committee has presented the list of those winning the national prizes, those who were first and second in each of the states and the District of Columbia, and has given a list of the educational institutions offering scholarships. The new booklet carries an extended bibliography of books suggested to be read in connection with the contest and also more detailed specifications regarding the contest of 1924–1925, to which have been added cash prizes for essays submitted by undergraduates in colleges and universities. Present indications are that the students of some five hundred institutions will be eligible to compete for these cash prizes.

Following the contest a questionnaire was prepared and sent out to all schools. These questionnaires asked:

How many students prepared essays?
How many essays were submitted in the contest?
How many students read the five reference books donated?
Has your school a course in chemistry? Physics?
Has your school a science club for students?
Has your school a student paper or magazine?
How many students are enrolled in your high school?
Is your school accredited by a university or other authority?
What, in your opinion, were the benefits derived from this contest?

The statistics given in the appended table were compiled from such

of the questionnaires as were returned. The committee felt it could not afford to follow up those who did not return the questionnaire in the first instance and, as a comparison of the first and third columns in the table indicates, the number of questionnaires returned gives us insufficient figures upon which to base many definite conclusions. However, from the correspondence of the committee, visits to many schools and general information, we feel justified in placing the number of students actively interested in the contest at approximately 500,000. All questions were not answered on all the questionnaires returned. This is the familiar experience of those who endeavor to obtain statistics in this manner, but it is believed that the data presented may be of interest to those giving special attention to high and secondary school courses.

No effort can be made here to quote from a very large number of commendatory letters received. It is believed that the purposes of the contest were achieved and because of this belief after carefully considering the apparent results, Mr. and Mrs. Garvan renewed and amplified their original gift, so that as announced, the contest continues during 1924–1925 with every expectation of increased results nation-wide in their benefits.

Respectfully submitted,

W. D. BANCROFT,
C. H. HERTY,
H. E. HOWE, *Chairman*,
ALEXANDER WILLIAMS, JR., *Sec'y*.

THE RELATION OF CHEMISTRY TO THE DEVELOPMENT OF THE INDUSTRIES AND RESOURCES OF CALIFORNIA*

EUGENE BROWNSCOMBE, 839 THIRD STREET, SANTA ROSA, CALIFORNIA

Winner of First Prize

Our national standing and even our individual happiness depends, to a large extent, on our industries. The industries in turn depend upon the initiative of the people and the resources they have at their command. California in the matter of minerals, timber and soil is wonderfully blessed, and with extraordinary water and rail transportation facilities and a people of vision and capacity for work has built an empire in three quarters of a century.

In this paper it is proposed to give each of the California industries comment in proportion to their importance judged from a chemical standpoint.

Although many people think of California as the "Golden West" where farming and motion-picture making are the chief occupations, California's mineral resources are of great importance. She yields a greater variety of mineral products than any other state in the Union, and is surpassed

* This essay was accompanied by map of California, showing the locality of mineral resources and of the chief industrial concerns now applying chemistry.

in wealth derived from minerals only by four or five other states; those being the great coal states east of the Mississippi. She leads all others in the production of borax, chromite, magnesite, gold, quicksilver and platinum, and has alternated in the lead with Colorado in tungsten and with Oklahoma in petroleum. California led Oklahoma in 1922 and from figures available has increased her production in 1923.

In the discussion of the mineral resources the order followed will be that of their value according to the latest state reports and not according to their chemical relationship.

Petroleum is California's most important mineral resource. It is found chiefly in the southern part of the state as shown on the accompanying map, Kern county being the largest producer. Chemical science is used extensively in the testing of oil for its fuel value and water content, in addition to its place in the refining of the crude oil. The constituting hydrocarbons of the oil are separated by fractional distillation and are washed first with sulfuric acid, then with an alkali, and finally with water to remove all impurities. Chemistry has greatly aided the oil industry by finding uses for the various by-products of refining and in greatly improving methods for purifying the main products. Formerly kerosene was the most important product derived from petroleum, but since the advent of motor cars and consequent demand for gasoline, every effort has been made to increase the yield of this substance. It was found that by heating the oil under pressure the yield of gasoline could be greatly increased—due to molecular changes. By this process benzene and toluene are also formed, and chemists have already created a demand for these liquids by making dyes and medicines and valuable explosives such as trinitrotoluene. The liquids themselves and the trinitrotoluene are produced in considerable quantity in this state. Ceresin, a wax similar to paraffin, also is made into bottles and used as a container for reagents which attack glass, such as hydrofluoric acid. The value of California crude petroleum in 1922 was over $173,000,000, and that of the refined products vastly more. This is an index to the magnitude of the oil industry in the state.

In the recent earthquake of Japan it was noticed that while the Japanese brick and mortar buildings crumbled to the ground, the American-built steel and concrete structures remained intact. This shows the great advances being made in construction materials. By the chemist's careful testing of raw materials, by his explanations of reactions which take place during the calcining of the materials, and later, in the process of setting, the manufacturer is able to modify his material and processes so as to produce most economically the highest grade cement. The value of cement rock treated in our state in 1922 was over $16,000,000, and the value of the cement manufactured was $11,258,000.

California at present produces one third of the United States production of gold and stands first among the gold-producing states. In the days of '49 gold was obtained by placer mining. Now, however, 62½% is obtained by deep mining. In this state much gold with its alloyed silver is obtained by amalgamating with mercury and subsequently removing the mercury by volatilization. Also by dissolving the gold in sodium cyanide much is recovered and then removed from this solution by treatment with zinc or by electrolysis.

Brick and tile are increasing as a mineral industry in California and the chemist's watchful eye has enabled the producers to select the best raw materials and to prepare the best charge preparatory to firing.

A large per cent of the silver of California is obtained as a by-product of the refining of copper, lead, zinc and gold ores. It is separated from them by electrolysis and is left with the gold as a mud in the bottom of the tanks while the base metal is deposited on the cathode as a current is carried through the solution. It is separated from the gold by subsequent dissolving in nitric acid. The location of the smelters and refineries as well as the other industries applying chemistry will be found on a map accompanying this paper. This will convey best the importance of smelting and refining.

Copper, next to gold, is California's most profitable metal. Although much of the copper ore is concentrated by the flotation process and shipped to Utah smelters for refining, some is smelted here by roasting and treating with charcoal after which the "blister" or crude copper is electrically refined to obtain gold and silver and to free the metal from those and other impurities as previously discussed. Of course chemical control work is necessary in many steps in the mining, milling and smelting of copper as well as the other metallic products of the state.

California has long been the sole producer of borates in the United States. The most important compound of boron is sodium tetraborate or borax. This salt does not occur in quantity in California but is made by treating colemanite with sodium carbonate, sodium hydroxide being obtained as a by-product. Boric acid as well as borax, indispensable in modern life, is made by treating borax with sulfuric acid.

In ancient times various tribes in Italy used to fight for possession of localities where salt could be obtained from sea water. Venice was first noted for its sea salt industry. In this state Alameda County is the largest producer of salt. The process used there consists of allowing sea water to run into large shallow basins at high tide in April, May and June, and then depending upon solar evaporation to remove the water. The salt is harvested from these basins in the autumn and that which is desired for table use is redissolved and treated with sodium carbonate and calcium chloride to remove by precipitation much of the associated calcium and

magnesium salts. The salt is then evaporated rather quickly under a partial vacuum in order to obtain small crystals. To these crystals about 1% of magnesium carbonate is added in order to prevent the salt from caking by moisture absorption. Some plants, however, merely produce crude salt for making ice-cream, for cattle, for preserving meats and as the raw material for the preparation of other sodium compounds.

As would be expected in a locality where a great deal of cement is produced, lime also is made on a large scale. By calcining limestone over $610,000 worth of California lime was produced in 1922. This found use in sugar refining, as a smelter flux, as fertilizer, and as building material. The value of lime in mortar and cement involves the interesting chemistry of union with water to form crystalline hydrates, and the later union of these with the carbon dioxide of the air to form hard, compact limestone.

Magnesite, or magnesium carbonate, is found to be very useful in iron and copper smelting. The reason for this is that it fuses at a very high temperature and is not attacked by the molten metal. Magnesite when mixed with magnesium chloride and asbestos fiber or sawdust in the correct proportions sets to form a cement which is said to be much better than Portland cement in that it is much more resilient, and tough, and adheres strongly to surfaces on which it is laid. It is a poorer conductor of heat and hence is less likely to crack. Chemists are employed in making this cement to analyze various ingredients and to see that they are mixed in the correct proportion. Even a very small percentage of lime will spoil the cement; so it is essential that the substances used be reasonably pure.

California in 1922 produced $570,000 worth of pyrite or iron sulfide for the manufacture of sulfuric acid. This acid is probably the most important chemical reagent. It is used to prepare a great many other acids and sulfates and most extensively for the preparation of explosives and fertilizers. Both the contact and lead-chamber processes are employed by California plants. The value of the 1922 production of pyrite was $473,735.

Sodium carbonate, or common washing soda, has many uses other than softening water. It is used in the manufacture of glass, soap and of many sodium compounds which are rapidly replacing the more expensive potassium ones. Soda is found in some quantity in the alkaline lakes of southeastern California and is separated from its associated minerals by fractional crystallization. Some is also produced from salt by the well-known Le Blanc and Solvay processes.

Inyo County, notable as containing the highest and lowest land in the United States, produces the most of California's lead. The Selby Smelting and Refining Co., at Selby, smelts a great deal of this ore by roasting in air and smelting with carbon. By this method the galena (lead sulfide)

is changed first to lead oxide with the liberation of sulfur dioxide, which is used in the preparation of sulfuric acid, and then to metallic lead, with the liberation of carbon dioxide. Most of the lead prepared is used in the paint industry by treatment with acetic acid by using the old Dutch process. The manufacture of white lead and other paint pigments constitutes in itself an important state industry. Much lead too is used in the state to produce alloys such as babbitt, solder and type metal.

Mercury is unique in that it is the *only* metal that is a liquid at ordinary temperatures. No satisfactory substitute has been found for its fulminate compound used in primers for cartridges. For this reason, and the fact that foreign supplies were cut off during the war, the California production was greatly increased in that period, constituting more than 70% of the United States production. The use of the metal in the recovery of California gold has been mentioned previously and its use in scientific instruments is well known to everyone. The mineral occurrence of quicksilver is cinnabar. This mineral is readily reduced by roasting in air. The mercury is then freed from any metals held in solution in it by adding an oxidizing agent, such as nitric acid which oxidizes the associated substances but not the mercury.

California's first commercial production of zinc was in 1906, and a considerable production has occurred in every year since. It is obtained as a by-product of lead and copper smelting and is converted into zinc oxide and later finds it way into paint. The metal itself is an essential ingredient of brass produced in considerable quantity in California.

Agriculture is the backbone of California's prosperity and chemistry is vitally connected with its success. In modern dairying the milk must be tested for butter fat and the cheese for casein, and in all farming one must appreciate the value of chemically prepared fertilizer in soil enrichment, and sprays and insecticides in the protection of plants from disease.

California's greatest agricultural asset is fruit. About thirty different kinds of fruit are produced in commercial quantity. Of these the citrus fruits are the most important. The chemist figures here in determining the per cent of sugar necessary for certain market grades, in utilizing the low grades of lemons for the production of citric acid and in protecting the growing trees from insect pests by providing hydrocyanic acid and other insecticides. Just as hydrogen cyanide is the most important citrus spray, nicotine sulfate is the most important insecticide for walnut trees; being especially efficient in killing walnut aphis. It is not applied as a spray but is used as a dust mixed with lime and sulfur. Probably most of us are familiar with the extensive use of lime-sulfur spray in treatment of prune, apple and similar trees. It is a mixture of the persulfides of calcium made by boiling a solution of calcium hydroxide with sulfur. Lead arsenate is a chemical frequently used in fighting many common

insects. Chickens are often greatly bothered with various pests, such as lice and mites. These are usually eradicated by applying various chemicals under the wings and by thoroughly disinfecting the henhouse with a solution of ferrous sulfate, kerosene or carbolic acid. When rats are bothersome in poultry farms strychnine poisoning is resorted to. California ranchers use solutions of potassium permanganate, hydrogen peroxide and creoline in treating diseased poultry, and calcium persulfide, nicotine compounds and cresol for sheep and cattle dips.

California, though not yet in the same rank as the Atlantic seaboard states, nevertheless is rapidly developing manufacturing and in the production of at least sixty products uses chemistry directly. The location and number of these plants has been referred to on the accompanying map. In discussing the mineral products the chemistry of a number of these products was discussed. In the limited space left it will be possible to discuss only a few of the remaining chemically prepared products.

California boasts of seven automobile plants which use chemical science in the preparing of the steel and the many other materials that go into the finished product. This is illustrated by the special tungsten or molybdenum steel alloy used in the firing points of the spark plugs, condensation products of formalin and carbolic acid used in the electrical apparatus, strontium compounds in the tail-light glass, antimonial lead alloys in the bearings.

As indicated elsewhere, chemistry is essential in steel manufacture in keeping track of the percentage of silicon, carbon, sulfur and phosphorus of the ore and smelted product and of the composition of the charge used.

California is producing paints of a yearly value of $11,000,000. Her chemists produce many of the pigments, vehicles and driers used and make frequent durability tests of the finished product.

Only a few years ago beet sugar was little known in the United States. Now multitudes of Americans with a taste for sweets use the product of the eight California refineries. The process of refining sugar from beets is essentially the same as from cane; a solution of the juice is vaporized under a partial vacuum to prevent charring, the crystallized sugar is then dissolved, filtered and distilled again. The mother liquids from the stills are used to make alcohol by fermentation. During the filtering and evaporating several chemicals are used to cause separation of foreign substances and many analyses are run by the chemist throughout the process.

The application of chemistry to the Golden State's $21,000,000 tanning industry is shown by the use of oil, lard, soap of several kinds, alum, salt, sodium sulfate, salt peter, sal soda, borax, saleratus, sulfuric acid, Japonua and dyes during the process.

Creameries are widely distributed throughout the state of California,

as is noted on the industrial map, and produce an unsurpassed grade of butter. In buying milk and cream they make tests for butter fat content using the Babcock method of separation with sulfuric acid.

In California fruit and vegetable canning, sodium benzoate and other preservatives are sometimes added; especially in the preparing of catsup and like foods which stand open for some time during use. Meat packing requires the use of ammonia in refrigeration and chemically prepared disinfectants are freely used around the plants. Many products like glue and potash compounds are prepared from slaughterhouse wastes.

A word limit prevents adequate description of the role assumed by chemistry in the state's important soap, borax, acid, explosive, photographic film, paper and food products industries, but if such a limit were not imposed an interesting story could be revealed of the chemist's role in each. They cannot get along without his guiding hand and the products his ingenuity has provided.

Recently, workable deposits of coal have been found in Humboldt and Mendocino counties. Iron ore of quality is known to exist in quantity in several localities, but because of the lack of cheap coal remains undeveloped. The Orient is unquestionably the future market for California's manufactured products. To develop the abundant resources of the state, cheap fuel is essential. This lies as yet undeveloped on a large scale in the mountain vastnesses of our state. Potential water power of the Sierras and steam power of the Coast Ranges in Sonoma County are adequate to generate electricity to fully develop these resources. Steel, the valuable electric furnace products, nitrogen fertilizer, glass, cement and the other desirable products for local and foreign markets will some day be produced by this fuel. Then California will take a first position as a manufacturing as well as a mining and agricultural commonwealth.

THE RELATION OF CHEMISTRY TO AGRICULTURE AND FORESTRY

Oliver C. Pittman, Commerce, Ga.

Winner of First Prize

The human race has always been dependent directly or indirectly upon the products of field and forest. Our very existence is menaced or enhanced by the forces which increase or decrease the supply of necessary commodities derived from the forest and farms. Therefore, the relation of chemistry to agriculture and forestry should be one of common interest.

We live in an age of chemistry. There is no art or industry of modern civilization which does not require the constant aid of chemistry. It is the basis of medicine, a fundamental factor in the treatment of disease; it is creating new industries and opening up new avenues of commerce;

it has revolutionized warfare; but nothing is so far reaching in effect or so beneficial to mankind as the application of chemistry to the problems and products of agriculture and forestry.

America's rapidly increasing population demands a corresponding increase in the production of foods, fabrics and building materials, of everything in fact, which is necessary for the maintenance of life. Without the aid of the chemist the farmer and forester would soon exhaust their resources and deplete their supply.

The chemist, however, has enabled them to increase the quantity and quality of their products in two ways; first by analyzing soils, by studying the food requirements of various plants and by supplying food substances which the soil lacks; second by protecting the plants and trees from insects and disease. Chemical effort in this direction has achieved much. More than a hundred years ago Davy and Liebig attempted to analyze the soil and determine the composition of plants. These beginnings did not result in any immediate increase in production, but they served to create interest, led to further and more careful investigation and experiment and placed agriculture upon a scientific basis. All of this has finally resulted in a general knowledge of plant requirements and enabled agriculturists to produce more without bankrupting the soil.

Only thirteen of the eighty elements occurring in nature are required for plant growth. Three of these nitrogen, potassium and phosphorus are required in large amounts, but seldom occur in available form or in sufficient quantity to support vegetation continuously for a great length of time. For this reason it has become necessary to annually supply these substances in the form of chemical fertilizer.

The last of our lands have been staked out in homesteads. There are no new fields to which the agriculturists may turn. The World War prohibited the importation of fertilizer materials and in addition depleted the natural supply in the manufacture of munitions and explosives. The solution of the American fertilizer problem is largely in the hands of the chemist. Calcium phosphate abounds in the South and West, nitrogen is as free as air, but we are dependent upon the chemist to transform these substances into suitable plant food. The farmer is looking to the chemist, too, to discover some means of securing the supply of potash needed for growing crops. Past achievements point toward a successful future wherein the farmer with the chemist's aid may realize the complete triumph of agricultural chemistry and increase soil fertility with the production of every crop.

The chemist's task does not cease when he has supplied the plant with food for rapid growth and fruitage. Disease is as common to plants as to human beings. Disease and insects annually take a large toll in both tree and plant life. The farmer who does not treat these incon-

spicuous enemies of vegetation suffers a material loss and endangers future production. It is almost impossible to grow any sort of crop without the aid of chemical sprays. The yield of potatoes, pecans, peaches, corn, tomatoes, beans, apples, pears, grapes and of nearly all vegetables and fruits is more than doubled if the plants and trees are protected from disease and insects. The chemist has rendered an inestimable service to the farmer, fruit grower and lumberman, by placing at their disposal chemicals which will check the ravages of insects and disease.

Especially are the people of the South grateful to the chemist. The future production of cotton, the South's greatest monetary asset was seriously threatened by the invasion of the Mexican weevil. Experiment and tireless study on the part of agricultural chemists have resulted in a practical and profitable method of weevil control by poisoning with calcium arsenate. This achievement alone has been worth millions, not only to the South, but to America, for cotton is a leading product in international trade and commerce and is essential in the manufacture of scores of necessities and luxuries.

Not alone for increased production throughout the vegetable kingdom are we indebted to the chemist. He has gone a step further and applied the transforming science of chemistry to the things he has caused to grow from the soil and made them into thousands of useful articles. The chemist has made every part of nearly every plant that grows serve some useful purpose to man. Chemistry has found in plants every element of nutriment for man and beast. From the humble plants man is now able to clothe himself like Solomon or like the lily as his taste prefers. And from the plants too, chemistry has found cures for many human ills. In doing this the chemist has preserved the balance between supply and demand; enabled the grower to receive a better price for his crops and placed agriculture on a sounder financial basis. In this sphere of creating and transforming chemistry excels, performs modern miracles, and renders to the civilized world a great service. Indeed present day chemists may be likened unto King Midas of the Golden Touch changing the humblest substances not into gold, but into products whose value frequently equals or exceeds that of gold.

The American corn crop has always been an economic necessity. It supports a large per cent of animal life, and is an important cereal in the human dietary. The value of this grain has been tremendously increased since the chemist separated it into hull, body and germ, obtaining from the hull, bran; from the body, starch; and from the germ, oil. These substances have been the foundation of many other products, so that altogether more than a hundred commercial products are made from corn. And the chemist, great economist that he is, is trying to find a use for the cobs, so that nothing may be wasted.

Chemistry has found 147 uses for peanuts, raised the price from 30c. per bushel to $1.50 and put new life and hope into the heart of the Southern farmer whose cotton fields are infested with boll-weevil.

Cotton when grown for the fiber alone was a valuable crop. The fiber clothes a very large per cent of the world's population and supplies a foundation for the manufacture of paper, explosives and plastics. The chemist had added some $150,000,000 annually to the value of the crop, by discovering manifold ways of utilizing the seed, which were for so long thought useless and consequently thrown away. This seed has been separated into three parts, linters, hulls and meats. Each of these in turn has been made into scores of useful articles. From the linters are made batting, wadding and stuffing material of many uses, absorbent cotton and cellulose. The hulls are used chiefly for feed, fertilizer and fiber which furnishes cellulose, pressed paper products and a basis for explosives. The meats are a most prolific source of crude oil, cake and meal. The latter being converted into feed, fertilizer, flour and dye stuffs. The oil is refined and used for food purposes. By products of refining are utilized in manufacturing soaps, linoleums, roofing tars, oil cloths and artificial leathers. As meats and dairy products become less plentiful and more expensive, we shall come to depend more and more upon the vegetable fats and oils.

The work of chemistry in finding and developing the latent materials in cotton seed, peanuts and corn, is representative of the marked development that has been brought about in practically all agricultural products by means of this wonderful science.

The relation of chemistry to forestry is equally important. Perhaps no other one material is so widely used or enters our daily life in so many ways as does wood. There are two ways and only two in which our wood requirements may continue to be met. One of these is to grow more wood; the other is to use more effectively the present supply. The chemist hereto-fore has been but little concerned with the cultivation of forests. Forest growth took place as a result of chemical action in the air and soil, without artificial aid. However if reforestation is to be secured, the chemist must acquaint us with the conditions necessary for forest growth. Full productiveness of the reforested areas cannot be secured without full information regarding the agencies which control forest growth. The chief duty of the chemist in regard to the present supply is conservation. In this he has succeeded nobly. Forest depletion has reached a dangerous and critical point. The problem is first, to find a way of utilizing the 75 per cent now wasted and to make low-grade material made from inferior second growth forests answer instead of high-grade material formerly demanded; second, to defy the decay producing organisms by treating all wood used under conditions where it is subject to decay with some good chemical preservative.

Built up construction offers a golden opportunity for the utilization of low grade and waste material. By making a good wood glue, the chemist has made this process, which consists in gluing together small pieces of wood to build up an article, usually made of solid wood, practical and profitable. The glued joints are as strong and frequently stronger than the wood itself.

Wood is a complex chemical substance from which a host of other chemical products are obtained. Products derived from wood are now used in the manufacture of news and writing paper, linoleum, silk, gunpowder, ink, soap, varnishes, paints, celluloid, chloroform and iodoform. The most conspicuous of these, perhaps, is paper, 90 per cent of which is made from wood. Spruce, Hemlock, Balsam and Poplar have supplied a greater portion of the pulp. The chemist has now found that fifty species other than these may be used equally as well. The southern yellow pine hitherto regarded as most unsuitable is used to manufacture wrapping paper. The short leaf pine mixed with hardwood makes good book paper.

By substituting for wood pulp second cut cotton linters and hull fiber the drain upon the forest has been materially decreased. This work of chemistry in opening up new sources of supply, introducing more efficient methods of manufacture and in developing material previously wasted has gone a long way toward forest conservation.

Chemistry seeks a further saving of material with an estimated value of $16,000,000 now lost through the decay of wood and wood pulp while in storage.

Wood alcohol is a chemical product not to be scoffed at despite the fact that it will not pass muster as a beverage. Together with charcoal and acetate of lime wood alcohol is a product of distillation. All of these substances are used in various chemical manufactories. Charcoal is valuable as a fuel, as an insulating material, as a clarifier in refining sugar and in smelting ores. From the standpoint of our wood supply these products are important not only because of their intrinsic value, but because they afford a profitable means of utilizing small crooked trees, limb wood and slabs.

The distillation of resinous woods gives wood turpentine, tar oil, tar pitch and charcoal. Wood stumps and waste wood have been used in this process and the yield of naval stores increased.

Chemistry has found a way to convert, the sawdust, which represents 13 per cent of the wood in the log, into a carbohydrate food for cattle. Perhaps a still more promising use for sawdust lies in converting it into grain or ethyl alcohol, which may be substituted for gasoline as a motor fuel. It is estimated that some 300,000,000 gallons of alcohol could annually be produced from the material now wasted at the mill.

So in hundreds of different ways chemistry is proving a most essential

factor in successful agriculture and forestry. The future safety and prosperity of America, revolve about the problem of lifting agriculture from depression and forestry from destruction and decay. Chemistry alone cannot solve the problem. It is a problem of education, commerce and finance, but chemistry has ushered in a new day for agriculture and forestry and perhaps the aim is not far distant, when Burbank's prophecy may be fulfilled and the future destiny of all mankind be ennobled and advanced.

THE RELATION OF CHEMISTRY TO THE HOME

BENJAMIN NASSAU, HARTFORD PUBLIC HIGH SCHOOL, HARTFORD, CONNECTICUT

Winner of First Prize

The science of chemistry wields an influence upon our everyday lives which is but little realized by the average human being. Day after day we continue to use the manifold comforts and conveniences with which chemistry has supplied us, rarely thinking of all the toil and hardships which were necessary before they came into existence. The chemist, that human being to whom are known the vast secrets of nature, bending over his crucibles and retorts and other chemical implements of his laboratory, has brought forth astonishing substances from seemingly useless and valueless materials. He has created vast industries which have developed the natural resources of our nation. He has furnished our war department with munition to provide for national defense. He has supplied our farmers with fertilizers to grow the crops which feed the country. He has given to our physicians and surgeons the necessary materials to prevent disease and fight death. But, chief of all, he has given to our homes and to our home lives all the blessings of wholesome, comfortable living.

In this relation to the home the influence of chemistry is universally present. Wherever we turn, and what ever we use, it directly or indirectly affects us. Volumes can be written on the various phases of this relationship; but in a short treatise like this only a few of the more important points can be mentioned.

The part that chemistry has played in the development of our homes is, perhaps, nowhere more clearly shown than in the growth of our great soap industry. The extent of the use of soap, a factor which has been suggested as a criterion by which the culture of a people may be judged, has become so great that we little realize what an important part it plays in our modern civilization, and for how short a time it has been used in any considerable amount. As man rose from the stages of savagery and barbarism he learned to recognize the desirability of cleanliness. Struggling for some means to facilitate the removal of dirt, he discovered that a mixture of grease with wetted wood ashes would accomplish this feat. This crude method of making "soap," until recent years, has been very

largely a household art, and the result was that real, comfortable cleanliness was a luxury which could be purchased only by the rich. Then the chemist came to the rescue. He perceived the need for the production of soap on a uniform, extensive scale. He took salt and water and produced caustic soda, which he mixed in definite proportions with fats and oils, and created that blessing of the home—the bar of soap.

But the chemist did not stop here. As the demand for greater cleanliness in the home began to increase, he brought into existence various cleansing substances which have their particular uses. The caustic soda which he used in the manufacture of soap we employ under the name of lye to clean drain pipes and floors which are badly caked with dirt and grease. Soap powders and washing soda are used to a great extent for all kinds of rough work. Through his knowledge of solutions for the various staining materials the chemist has given us means to remove practically any stain which may mar the appearance of clothing, woodwork, and in fact everything which exists in the home. Indeed, the chemist can well be said to have made our homes clean.

Yet, even more important than its contribution to cleanliness in the home is the development of newer theories of nutrition and newer means of preparing our foods which chemistry has brought about. Many old, inconvenient, unsanitary methods of dealing with our food supplies have been discarded, and new, scientific methods have taken place. A typical example of this improvement is the development in the proper handling and pasteurization of milk, so that the danger from the spread of contagious diseases by this means has been greatly eliminated in cities and towns where adequate chemical control is provided for. It is the great chemist Pasteur who has made millions of homes bright and healthy by his discovery that milk, the primary food of the child, can be safeguarded from contamination by the process named after him. It was chemistry, personified in this great scientist, which has made possible that picture of the happy home, wherein is depicted a child complacently drinking milk from the bottle held in the hands of its mother, who is confident as she watches her baby that there are no wicked germs in it to do her child harm.

The proper preservation of all food products, including meats, vegetables and fruits, enabling us to have a varied diet available at all times, is another triumph for chemistry in its relation to the home. In a country like ours, where very often the seat of production is so far removed from the place of consumption, the need for preserving the many perishable food products for all-year-round use has been very great. How to overcome the tendency for meats, vegetables and fruits to decay was the problem which faced the chemist. He solved that problem, and today we can procure in a grocery store practically any food product desired in a

container, which keeps it as fresh as when it was first placed there. This preservation of food has proven a blessing to every one. The laborer who takes his lunch with him most likely has canned milk and ready-cooked preserved meat for his noon meal. The housewife need no longer spend the greater part of the day over her kitchen stove. Canned beets, tomatoes, asparagus, soups, meats, and other products serve to eliminate labor on her part, while the ready supply of all kinds of canned fruits furnishes her with the choicest of desserts at a minimum of bother.

Along with the preservation of food products comes the development of bread making to the point where it is generally conceded that bakers' bread made in the proper manner is more sanitary and convenient than the old home-made bread. The relation of the chemist to this development may not be so apparent, but nevertheless it does exist. He has taught these bakers who produce our bread on such an enormous scale the proper uniform method for making their product. (He also acts as supervisor and inspector, and sees to it that the bread we eat is wholesome and free from any adulteration whatsoever.) In home baking he has been equally busy. He has invented baking powder to supplant the more inconvenient method of raising dough by the use of yeast. In the home, when the so-called "quick-breads" such as biscuits, pastries and cakes are to be made, to leaven the dough by the use of yeast takes too long and is a much less certain process, inasmuch as the amount of leavening gas escaping is uncertain. In discovering baking powder, a distinct chemical product, the chemist has given us the means for quick leavening action combined with greater uniformity in results. Again, he has added convenience and expediency to the home.

In the solution of the problem of obtaining good convenient cooking fats has come one of the most remarkable achievements of chemistry in its relation to the home, namely, the hydrogenation of oils. This process has made it possible to start with an oil which is entirely liquid at ordinary temperatures and make of it a brittle mass as hard as the hardest candle stearin, or to arrest the process at any stage and get a fat of any consistency required. The housewife, who had to use either lard, which was not acceptable to some people on account of digestive disturbances or religious restrictions, or a liquid fat which was highly inconvenient to handle, has been supplied by the chemist with desirable semi-solid cooking fats artificially made which are better in many respects than the natural products.

Yet, more important than all these contributions of chemistry to the food problem of the home, comes the formulation of the theories of nutrition, which have now become common knowledge and which enable us to prepare a better balanced diet from which the maximum nutritive value may be obtained. The struggle to discover all the factors necessary for

the proper functioning of the human body has been a long and difficult one, and it is only at a recent date that we have learned the true relation of the various foods to our body. The requirements of human nutrition have been formulated in explicit, scientific and practical terms. We know now how to use our food supplies to the best advantage in order that all people may be as well nourished as possible. And good nutrition is a very large factor in the health and happiness of our home-life.

Aside from its relation to food and cleanliness, chemistry has created for our homes countless articles of furnishings which we use and enjoy without thinking that they were made through chemical processes. Artificial silk, manufactured from cotton fibre, and mercerized cotton, prepared from cotton cloth have afforded us materials which are more economical than the genuine product, but which serve the same practical purpose. We can now purchase an artificial silk tie for twenty-five cents which looks as well as a dollar silk tie and which will wear long enough for the wearer to tire of it. Even net and lace, which formerly had to be made by the laborious and drudging process of manual labor, can now be manufactured by machine, due to the discovery by chemistry of a solvent for cellulose. Artificial rubber has been prepared by chemical means. Leather, which is made from the hides of animals, can now be manufactured from cotton, ether and alcohol, so that a vegetarian can with quiet conscience buy shoes which contain not a trace of material obtained from living matter. The oil cloth found in so many homes is made chemically from canvas and linseed oil, while the linoleum upon which so many people tread is manufactured from ground cork and linseed oil. Canvas, coated or impregnated with soluble cellulose, furnishes us with new fabrics that are better, cheaper and more abundant than leather, which they have replaced in many instances. What valuable and useful substances have been made from mere cotton-waste, rags, paper and even wood-pulp!

But a few years ago almost all dyes were extracted from plants and trees, and besides being dull they were comparatively rare and expensive. Chemistry, however, brought about a radical change in existing conditions. Sixty-eight years ago a chemist named W. H. Perkin prepared the first dye from coal. The preparation of others soon followed, until today thousands of these dyes of every variety of color are manufactured. These aniline or coal-tar dyes have almost entirely superseded the old vegetable dyes. The coloring of clothing and materials has become a much more inexpensive process.

The cooking utensils and the stoves and ranges in which they are placed all undergo chemical operations before they are placed in our possession. The cooking range is made in the blast furnaces of Pittsburgh from the iron rust of the Lake Superior region. The aluminum kettle is made from

aluminium oxide decomposed in the molten cryolite of Greenland by the tremendous electric power generated at Niagara Falls. The glass tumbler is prepared from sand, sal-soda and quick-lime, while the porcelain dish is manufactured in kilns from kaolin, feldspar rock and plastic clay, covered with a fusible glass glaze. The charcoal which is used to set fire to the coal is made from wood by heating in the absence of air, while the paper which sets fire to the charcoal is made chemically from wood-pulp or rags. The very match that first starts the combustion is a chemical product, made from bones, sulfur and fish-glue. The home is full of such valuable furnishings which owe their existence directly to the chemist.

The same relationship between chemistry and the home exists in the improved methods of heating and lighting which have been worked up by chemists in conjunction with engineers. The production of heat and light are in themselves chemical reactions, and the chemist's knowledge of combustion and light rays has aided a great deal the development of these two important factors of home life. The carbon filaments for incandescent lamps are chemically prepared from zinc chloride and cellulose, while the electric bulb itself, from which the air formerly had to be expelled, is now filled with a gas prepared by the chemist. The introduction of the new oil heating systems within the home is also due in the first instance to the chemist, who taught the engineers to construct them in such a way as to bring about the complete combustion of the oil, and in this way eliminate the possibility of unhealthy, uncomfortable odors escaping.

Finally, the improvement in all materials entering into the building itself of our present day houses is directly due to the work of the chemist. His knowledge of the chemical actions which take place when mortar, cement and concrete harden, and his knowledge of the properties of the various irons and other metals have brought about the present durability and beauty of home architecture. Our buildings are now constructed so as to form one massive, indivisible structure rather than a pile of a great number of stones, one on top of the other, as was the case in the old Roman houses. Our cottages have also been made more durable through the use of the various paints which prevent oxidation and thus remove the tendency for the wood to decay. The new plumbing and toilet fixtures are likewise the chemist's handiwork. In fact, almost everything which pertains to the actual building of our homes is made or personally supervised by the chemist.

Thus we see, with only a hasty glance at a few of the factors which appertain to the home, that the science of chemistry has exerted a great influence upon it. This influence continues to be left. Discoveries made daily by chemists all over the world, however, imperceptibly, are working towards a change of existing conditions. The chemist has opened and

disclosed to us many of the secrets of nature, yet his work is but begun. In this scientific age in which we live nothing seems impossible, and we know not what important truths may be revealed to us tomorrow. What is certain is that in the past the relation of chemistry to the home has been incalculably beneficial. Chemistry (the mother of all sciences it has been called) has done much to give to our homes the comfort, the health and the happiness which we now enjoy. We cannot doubt that it will continue to exert an ever increasing influence over these conditions in the future.

THE RELATION OF CHEMISTRY TO NATIONAL DEFENSE

ELTON R. ALLISON, 402 NORTH BUCKNER STREET, CENTRALIA, WASHINGTON

Winner of First Prize

Recognizing that this world has not yet experienced its last great struggle, and that in spite of Edward Bok, the League of Nations, the Washington Disarmament Conference, and various other so-called peace movements, there is little likelihood that great nations have lost the essence of national ambition for conquest, and that another great war is as certain as the daily presence of the sun in the heavens, the importance of national defense at once becomes apparent.

For any nation the term "national defense" means the problem of success in war. Chemistry has so much to do with warfare that no nation can look forward to victory if chemistry is disregarded. The national defense problem is vital to the existence of the United States. Chemistry will have much to do with the solution of this problem.

Chemistry has been vitally connected with warfare ever since the first gunpowder was used, but not until the World War brought out this vital relation did those concerned with national defense realize that the victorious nation in the next war would be that nation which is best prepared chemically for the struggle.

In modern warfare chemistry plays its most important role, perhaps, in the use of poisonous gases. These creations of the chemist are used directly upon the individual soldier in battle. The German army was the first to put these new chemicals into action. This was rather early in the late War. The horrible effect of this attack needs no description. Had Germany been prepared to use this new weapon extensively the war would have ended much sooner, leaving a complete victory to Germany. Why was it that the German war lords did not make a thorough and prolonged attack with their gases? It may be that the chemists lacked sufficient influence with the German army to cause such a campaign. We are glad this folly was committed, because we well know what a victory for Germany would have meant to the United States. As it happened, the

Allies were given time to prepare against this new offensive, and in a few months were, in return, using gases upon the German army.

The development of chemical warfare has made gases one of the mightiest elements of modern fighting. Both the Allies and Teutons created and used many chemical weapons. The United States soon recognized the possibilities of chemical warfare, and accordingly added a new branch to its army—the Chemical Warfare Service. Before the end of the war America was turning out toxic gases at the rate of two hundred tons a day, while the output of Germany was not more than thirty tons. This shows how greatly the United States valued this chemical weapon.

The first gas used was chlorine. Every one who has ever smelled the "breath" of bleaching powder is familiar with this gas. It is made from common salt and an acid. For battle use it was carried in liquid form in long cylinders; it was allowed to stream from these, to be carried to the enemy by the wind.

As free chlorine would not stay put, and was dependent on the favor of the wind for its effect, it was later used in volatile liquid compounds. These could be fired in a shell and so released at any desirable point. Several compound gases were used for this purpose, of which phosgene was the most common. In the World War this gas was very effective, because it carried no odor to give warning of its presence, and since a few short breaths would result in death.

Chlorpicrin was the compound manufactured in the United States in the largest quantity. It was formed by treating chloroform with nitric acid. Although not as poisonous as phosgene, it had the advantage of causing nausea and vomiting, thus forcing the soldier to remove his mask; he then fell an easy victim to other deadly companion gases.

Perhaps the most talked of gas was "mustard." This was not really a gas nor was it made from mustard. It was a combination of chlorine and hydrogen sulfide, gases which the chemistry student never forgets because of their horrible smell. These two gases, bad enough by themselves, formed a compound which was the most villainous substance used during the war. If a soldier once encountered it, he received an unforgettable impression. Its effectiveness depended upon its persistence. It lingered about trenches and dugouts for days after the attack, and was still effective. Being a stable liquid, it soaked into clothing and masks and lay in wait until vaporized by a warm atmosphere or the heat of the body. The gas which was given off caused a terrible burning poison to any part of the body it touched.

Besides these gases already described, there were many others, among them the tear gases and sneezing gases. The best of these may be used in the next war, but there is no limit to the number of new gases which the chemist may produce. The future use of gases in warfare is as un-

limited as war itself. The next war will cause nations to bring powerful new chemical weapons into service. The nation having the greatest chemists will have the advantage; the United States must be that nation.

Until the last, war gunpowder was considered of major importance. When a nation began to consider war, the generals first took stock of their supply of gunpowder. Since then the newer creations of the chemist have made gunpowder of secondary importance, but a war with explosives is not a thing of the past; on the contrary, improvements have come swiftly, until now they have reached the modern T. N. T., an explosive having many times the force of gunpowder. Chemists have wrought this development through study and research. Surely the most powerful have not yet been formulated, for creative chemistry is only in its infancy. Here again the United States needs trained chemists, if she is to keep up with the rest of the world in the production of powerful new explosives for warfare.

That nitrogen is the essential element in all explosives is the important fact to note. During the chemical reaction of any explosion, this nitrogen and other gases are given up from the compound, expanding with such force that a projectile may be thrown a hundred miles or more.

The trouble in making explosives is to get the proper nitrogen compounds. In nature nitrogen usually plays a lone hand. One of the very few places in the world where natural nitrates are found in the right combination is Chile. Since this was too far away from the theater of war in Europe, the task of securing other nitrates was left to the chemist. He solved the problem by turning to the air, for nitrogen is as abundant there as water is in the sea. The German chemists were the first to accomplish this, since Germany was soon cut off from the supply of nitrates in Chile. They discovered that one of the easiest methods was to use a strong electric current, but Germany was not blessed with the needed power to generate the necessary electric current, so they turned the search in other directions. They were so successful that Germany was able to use two hundred thousand tons of nitric acid a year, in explosives alone. Not a pound of this came from outside Germany.

The wars of the future will demand enormous quantities of explosives, but these cannot be produced in a short time. The United States cannot afford to rely upon Chile for her nitrates. She must be prepared to take them from the air, and that means that she must have trained chemical workers. Such independence from other nations for nitrates will greatly strengthen our national defense system.

As we reflect upon the metal industry of a nation we realize its very great importance to national defense. The modern army equipment is composed of thousands of different articles, most of which are made of some metal. The ships of our navy are made almost entirely of metals;

gunpowder would be useless without guns; all explosives are used to propel a metal projectile or to pierce a metal armor. Explosives and metals go hand in hand in their development. The improvements in one call for improvements in the other. The chemist has to shoulder all the work of this improvement; therefore, the defense of our nation will be weak if our chemists are not equal to the task. Even a slight superiority in metallurgy has been the deciding factor in many battles, and that same slight superiority may win or lose the next war for the United States.

Most of the new metals are alloys of steel with other ingredients, such as tungsten, chromium and vanadium. Our chemists should make steel alloys with ingredients obtainable in the United States, so that we will be independent of foreign nations for them. These new metals have made armor plate invulnerable, except to projectiles pointed with similar material; flying has been made possible through engines weighing no more than two pounds per horse power; high speed cutting tools helped the United States turn out munitions and other war essentials at a rate unknown before the chemists made the proper tool steel. The chemistry of metals is indeed of great value to national defense.

Many valuable chemical productions, useful in national defense, were made possible by the extension of the range of temperature at the chemist's command. The modern chemist, by means of the electric furnace, may produce temperatures which are three thousand degrees hotter than the sun. The oxy-acetylene blowpipe has made the welding and cutting of metals a very easy accomplishment, and thus through its relation to the metal industry it has played a major part in our national defense problems. The production of calcium carbide, which gives off acetylene gas when added to water, is a direct triumph of the electric furnace.

Carborundum, very useful in the metal industries as an abrasive, is another chemical product of the electric furnace. It has revolutionized shop-practice, and during the war it served in the production of many things needed in national defense, such as munitions, bayonets, and aircraft engines.

The cheap production of aluminum, the importance of which to national defense can hardly be over-estimated, was made possible by the electric furnace. The aviation branches of our army and navy owe their development to the use of aluminum in the building of strong light aircraft.

When we realize that the chemist must have efficient electric furnaces in order to do his best work, we see how important is electric power. Our natural water power should all be developed to generate the needed electricity. As has already been shown, a strong electrical current is also very useful in producing nitrates. Our national defense system will be greatly strengthened by an abundance of hydro-electric power, for it will give chemistry a chance to serve us in its largest capacity.

Nitrates play a double role in human affairs. They not only win wars, but they also produce crops. Incidentally the production of crops will also aid in the winning of wars, for a soldier cannot long fight on an empty stomach. One of the biggest problems of national defense is that of food supply. Chemistry has a direct influence on this through the fundamental importance of fertilizer production. The United States will have to pay more attention in the future, to feeding its soil, since our fertile lands are now nearly all under cultivation.

Nitrate is only one of the three principal chemicals used in fertilizers. The other two essentials are phosphate and potash. The chemist has already shown how the United States can procure plenty of nitrates, and she has more than enough natural phosphates. During the war the trouble was in finding a source of potash in the United States. Since Germany had a splendid natural supply, she was able to sell potash to the whole world. The United States was soon cut off from that supply. The chemists helped somewhat by finding new sources of potash, but these sources were either too limited or too expensive. *The Scientific American* magazine for the month of March, 1924, has announced that a natural supply larger than Germany's has been discovered in our southern States. Our Government should encourage the development of this deposit. Then the chemist could incorporate potash with phosphates and nitrates in fertilizers, thus adding to national defense by increasing the possibilities of food production.

One of the most perplexing problems of national defense is that of providing antiseptics, anaesthetics, sedatives and other medicines used in caring for sick and wounded soldiers. Chemistry has been very instrumental in giving the surgeon and physician the proper disease fighting weapons. Chemistry has even improved upon nature by removing the undesirable and harmful properties of such useful medicines as cocaine and morphine. The chemist prepared the medicine which relieved the awful agony of the wounded and made recovery possible. Those medicines which nature supplies are not abundant and warfare calls for such a vast amount that had not chemistry been able to create them from common materials, many of the wounded would have perished for lack of proper medical treatment. The importance of proper care for the wounded cannot be emphasized too strongly. The field of chemistry in this relation to national defense must be developed to the highest point of perfection. Our soldiers must have proper care when they fall in battle, and chemistry is the only means by which that care can be assured.

Germany's chemical industries had given her thousands of efficiently trained chemists. When the war called for chemists to carry on investigations behind the lines, these men were ready and equal to the task. When the Allies tried to find chemists to cope with the situation, they discovered

the appalling lack of such men in their industrial and university laboratories. The United States was in a similar predicament. It is obvious that the chemical industries of Germany gave her a tremendous advantage. In the next war the nation having that same advantage will be the victor. Everyone hopes that the United States will be that nation, but hoping for it will never get it.

If the United States is to have an army of well trained chemists, she must develop the chemical industries. That is the crying need. The next war will be fought on a tremendous scale. Chemical materials used in warfare will be consumed at a terrific rate, and our industries must have the production capacity which will be capable of filling wartime demands upon short notice. Our national defense security depends upon having these chemical industries before the war starts. The nation caught napping will in a few decisive battles, be snuffed out of existence with the latest chemical weapons. America must be awake, her chemical industries teeming with activity, so that when she is called to defend her shores against foreign invasion, or to uphold those ideals which have given her prestige among the nations of the world, she will advance, her victory assured by an army supreme in the arts of chemical warfare.

THE RELATION OF CHEMISTRY TO HEALTH AND DISEASE

DONALD L. VIVIAN, 3323 NORTH CENTRAL, PHOENIX, ARIZONA

Winner of First Prize

Health! That great gift of old Mother-Nature, so generously vouchsafed to those who obey her laws! To these favored ones life's troubles are insignificant, mere transient clouds in the summer sky; life itself but a vigorously flowing stream leaping and sparkling in the joyous sunshine as it wends its way to that vast, mysterious sea.

But, alas! To how many is granted this princely boon of true health! How many of us pursue our earthly journey unhampered by any of the countless ailments to which man is heir? Few, indeed, are those so beloved of Nature! Thousands, yea, millions of people daily demand the attention and care of medical science. By far the greater majority of these are successfully cured, but there still remain a vast multitude to whom modern medicine can offer little more than temporary respite from their pain. Is present-day medical science, in the light of this latter fact, sitting idly by and tranquilly accepting these diseases as incurable, or at best very doubtful of successful treatment? No! And again, no! Throughout the entire globe research work is unceasingly being carried on, that multitudes of sufferers may be brought back from that dark valley of the shadow and be restored to health and usefulness. Moreover, this research is not alone directed toward the discovery of specifics for

diseases which have at present no certain remedies, but also toward the betterment of existing medicines, and the improvement of present methods of procedure. And chemistry is one of the most potent factors in these efforts to aid suffering humanity, the noblest, most unselfish work that man can perform.

In order to substantiate this last statement, let us imagine that we are making a call on the eminent chemist, Professor Black. We are fortunate enough to call at a time when the hard-working scientist is not engaged upon any of his momentous researches, and is accordingly able to spare us a few minutes.

"Professor," we begin, "we would like to ask you why chemistry plays such a highly important part in the world-wide battle against disease. Why it is that medicine is beginning to turn more and more to chemistry for the solution of problems upon which depend the welfare and happiness of countless numbers now on earth and yet to come."

"Well," replies the Professor, "one of the chief reasons is that the chemist recognizes the true nature of the processes going on within the body. He knows that the living body is, in reality, an infinitely complex chemical laboratory, for he has shown that within it a vast number of extremely intricate chemical reactions are ceaselessly going on. The endless oxidation taking place within our bodies; the building up of bone and tissue; the digestion and utilization of food, indeed, practically all of the processes going on within the body, are chemical changes and as such are but phases of that great, everlasting change which is life. The chemist realizes that these fundamental, underlying chemical and physical changes determine in a vital way the health of the body, and that when the latter is diseased it is an absolutely certain sign that one or more of the countless reactions are progressing improperly or may have entirely ceased.

"Of these changes, however, we know comparatively little, and therefore find an extensive and fertile field in which chemistry can be of the utmost service to medicine. There are many factors which enter into the study of these bodily reactions, and in all cases the best line of attack lies in their consideration from the viewpoint of chemistry and physics. The time factor, for example, is an important consideration, since a healthy condition of the body demands that all of the myriad changes be taking place at exactly the right speed. Almost all of us can testify to this last statement, for at one time or another we have all experienced the pangs of indigestion occasioned by the slowing down of the digestive processes, an example of mal-adjustment of the time factor. Chemistry has found that in the living body there are certain substances called enzymes, and which have the power of being able to speed up the bodily reactions. While it is not precisely known just how the enzymes are able to increase

the speed of the reactions, the problem of finding out all about these mysterious substances is essentially one of chemistry, for scientists believe that the enzymes act in the same way as the catalytic agents of the laboratory. Then, too, physical chemistry has discovered many of the laws of speed of chemical action, and therefore this branch of the science is best fitted to undertake the question of the proper regulation of the bodily reactions, better equipped, indeed, than any other science to tackle the gigantic problem, ultimately to solve it and so to eliminate all diseases due to mal-adjustment of the time factor.

"Those much-discussed substances, vitamins, provide another example of the applications of chemistry in this field. The modern chemist has shown us the necessity of including fresh vegetables and dairy products in our daily meals, for he has proved that the so-called vitamins are present in these and similar foods and that these vitamins are indispensable to our health. The vitamin called 'fat soluble A,' for instance, was proved to promote growth and keep the body in good condition, thereby protecting the body against disease in general. It was also clearly demonstrated that 'water soluble B' prevents the disease known as beri-beri, while 'water soluble C' prevents scurvy. Furthermore, the chemist has actually succeeded in isolating the vitamins themselves, so that their beneficient effects may be more readily procurable. Here, then, chemistry has done much for humanity, for it has given us knowledge of how to help keep the body in good health, how to promote growth, and prevent beri-beri and scurvy. Too, the determining of the way in which the vitamins bring about their results is another problem which depends upon chemistry for its eventual solution.

"Then there is much yet to be done by chemistry in the study of our organs of internal secretion, for it is now a well-known fact that the secretions from certain glands play an extremely important part in the ceaseless changes going on within the living body. For example: the amount of the secretion from the pituitary gland determines to a large extent the rate of growth of the body, while the secretion of the thyroid gland has a marked effect upon mental activity. The chemically isolated active principles of the two above-mentioned glands are of much value, especially so the isolated principle of the thyroid. The latter principle, when artificially introduced into the body, has been found to be of inestimable benefit in many cases where the natural gland is deficient, for the artificially introduced principle, thyroxin, acts in much the same way as that which is produced within the body. In many cases where arrested mental development is due to deficiency of the thyroid, the administration of thyroxin will bring about a gradual, yet wonderful, change: the benumbed faculties take on a normal keenness, and the former unfortunate cretin takes his rightful place in the world as a mentally normal human being!

"Among other gland extracts is adrenalin or epinephrine, the active principles of the adrenal glands. Chemistry has not only succeeded in isolating this principle, but has actually determined its chemical structure and is thus able to make it artificially! This has been a great advance toward relieving one form of human suffering, for adrenalin allays those terrible spasms of coughing which occur in acute bronchial asthma. It is also of value for arresting minor hemorrhages, and is extensively used as a heart stimulant.

"It would not do for me to omit mention of insulin, that new preparation which is of such great value in severe cases of diabetes. This principle, while it will not ordinarily cure diabetes, will greatly add to the comfort of the diabetic by making it possible for him to assimilate carbohydrates, and will add years to his life. Much credit is due chemistry for the invaluable assistance rendered by it in the obtaining of insulin from the pancreas.

"These," said the Professor, "are by no means all of the applications of chemistry in the field we have been discussing, in fact, they are but a small part of the great number. However, let us pass to the consideration of another great field in which chemistry valiantly assists in the terrific struggle against disease. In taking up this new phase, I will first go back and mention a few historical facts which I believe you will find extremely interesting.

"The great development of medicine in the last few centuries is coincident with the rise of chemistry to the plane of an exact science. And there is a reason. Centuries ago, chemistry and medicine were vastly different from the sciences of today, for they were then founded mainly upon superstition and ignorance. Back in the days of the Egyptians, about two centuries before Christ, the belief started that the baser metals could be converted into gold, and for sixteen long centuries the alchemists fruitlessly continued to try to find the deep, mysterious process which would evoke the transformation. The physicians, meanwhile, had many strange and superstitious beliefs regarding their profession. They tried to accomplish cures by means of incantations, blood-letting, and a great variety of herbs which were popularly supposed to have magic powers. Nowadays, when we say that 'he got well in spite of the doctors' we are only referring to the extreme uncertainty of medical practice back in those early times of which I speak.

"Well, as I have said, medicine and chemistry continued along these lines for sixteen centuries; the physicians thinking up new and strange and awesome ways in which to make people believe that they knew everything that could possibly cure a disease, and the poor, deluded alchemists wasting time, money and everything else in their ineffectual attempts to convert base metals into gold.

"The awakening came in the early part of the 16th century, when a chemist by the name of Paracelsus recognized to some extent that the processes of life, in health and disease, are largely dependent upon chemical changes. He accordingly expounded the revolutionary doctrine that the true aim of chemistry should be to discover and prepare medicines, rather than to try to prepare gold from the baser metals. There was, of course, much opposition to this teaching, but gradually the alchemists began to see the error of their ways, and medicine was aroused from the torpor of so many centuries.

"Thus chemistry began the discovery and preparation of medicines on a scientific basis, and in so doing started the art of healing along the path of orderly and systematic development. It is to chemistry, therefore, that medicine owes the fresh start which it then obtained, and from which it has risen almost to the plane of an exact science.

"All this brings us to the second field in which chemistry renders magnificent assistance in the valiant fight against disease. This field is the discovery and preparation of new and better medicines, and in it there are two lines of attack: the chemist may start from natural remedies and improve upon them, or he may start independently of natural drugs and develop new and better medicines or specifics.

"An example of what has been done in the improvement of natural drugs is found in the betterment of cocaine. We have all heard of this drug, so valuable as a local anesthetic, in which function it has alleviated the sufferings of thousands. However, it has several serious defects, for it is rare, and therefore costly; it has undesirable poisonous properties; and it is very difficult to sterilize properly. For these reasons chemists set to work to improve upon it. After long, hard, painstaking labor, they succeeded in determining its chemical structure, which they found to be very complex, their being 43 atoms in the molecule of cocaine. It developed, after much investigation, that only one part of this molecule possessed the anesthetic properties, the other parts bore the poisonous attributes and were otherwise detrimental. Since they now knew the structure of the anesthetic part, the chemists were able to produce novocaine, a most remarkable improvement upon the original drug.

"You have, of course, heard of the remarkable results which are being obtained in the treatment of leprosy by the curative principles of chaulmoogra oil. This is another instance of chemistry's service to humanity, for the most remarkable results were not attained until chemistry had separated the active and valuable principles in the oil from the detrimental substances contained in it. Among many other examples of what has been accomplished along these lines, are included codeine, an improvement upon morphine, and theophyllin, a betterment of caffein.

These are only a few examples of the improvements made by chemistry upon natural remedies.

"The second line of attack, the preparation of medicines independently of natural remedies, is splendidly exemplified by a most dramatic incident which occurred during the great World War: At the beginning of the war, the medical profession was confident that methods had been perfected which could cope with and prevent infection of wounds. In this belief, however, they were sorely astray, for the war had barely started when they found that they were almost helpless before the terrible infections which invaded the wounds of the soldiers. The wound-inflicting missiles would gather bacteria as they passed through the clothing and would deposit the germs deep within the vital parts of the body, setting up therein a virulent infection while the wounded man lay waiting to be picked up. To combat these horrible infections, the surgeons had but two types of antiseptics: the mild and non-poisonous type, and the poisonous, burning disinfectant. The first of these types could only prevent infection, being powerless to stop the germs' multiplying if infection had already set in. On the other hand, while the second type of antiseptic would kill germs, it would at the same time destroy flesh and tissue, eating through cells and membranes and thus creating conditions as bad as the infection itself. If diluted to a point where it would no longer attack the body tissues, this second type would not be powerful enough to check infection. The situation was indeed fearful. The only means of checking infection in a limb was amputation, while if the wound was deep in the body, death provided the only relief from the terrible agony which followed infection. Seventy per cent of the wounded were dying—dying from the infection produced by the billions of germs that the wounds contained.

"All over the globe skilled workers were engaged in searching for an antiseptic strong enough to stop infection and at the same time harmless to the body tissues. Success finally perched upon the banner of the Franco-American surgeon, Dr. Alexis Carrel, and his co-worker, H. K. Dakin, the famous English chemist. Thus the famous Carrel-Dakin solution and treatment came into being, produced by the tireless workers who had experimented day and night with chemical after chemical, until they found an antiseptic which could be used to destroy bacteria in the deepest wounds without injury to the tissues. Here, indeed, chemistry and medicine served humanity to the utmost degree, for this amazing treatment has not only saved hundred of thousands of wounded from torture and death, but, still further perfected by chemistry, will save countless millions of lives in the years yet to come!"

Here the Professor pauses, but as we try to thank him he holds up a protesting hand, saying:

"Do not try to thank me, for I have enjoyed talking as much as you have listening, it is very seldom that I have such attentive listeners. I hope that I have in some measure answered your question, and I hope still more that you have seen the need for close coöperation between chemistry and medicine and that you will join me in the sincere trust that henceforth chemistry and medicine will work cojointly upon those problems whose solution will lead humanity out of the darkness of sorrow and suffering into the sunshine of health and happiness!"

THE RELATION OF CHEMISTRY TO THE ENRICHMENT OF LIFE

JAMES COLE REID, BRYAN STREET HIGH SCHOOL, DALLAS, TEXAS

Winner of First Prize

What fun the Connecticut Yankee had in King Arthur's Court; what amazement he caused in those medieval minds; what magical things he showed them and in what a miraculous way he saved his own life! At least it seemed miraculous to them and I have often wished that such an interesting adventure would happen in modern times—but of course that was an idle wish. It seemed a foolish wish until this year when I began a course in High School Chemistry—then magical things began to happen to me; magical doors opened; the treasures of Treasure Island began to dwindle in comparison to my discoveries and to the innumerable other things that I have not yet actually discovered but of which I have received faint glimpses.

Before I "took" chemistry I had heard of it, of course. Some who had gone before me spoke of its horrors, advising me to try something else; others promised that I would like it fine—"anyway, every man should know something of chemistry." None of my advisers gave me any idea of how wholly absorbing, how "terribly" interesting, the subject really is. Chemistry is not merely a subject in the High School curriculum to be studied in order to pass and have a clear record towards a diploma but it is something that is vitally related to our every day existence and enriches every part of our lives.

When I discovered that chemistry was a live subject I began to see some of the many ways in which it enters into our daily life. I can hardly touch an object now without trying to think in what way it has first been touched by the chemist. I now realize it would be almost impossible to live through a day without the assistance of chemistry.

When I wake in the morning the room is dark but a glance towards the clock reveals the time, for the numerals are illuminated with a radium preparation. The clock itself has been nickel-plated by an electro-chemical process. While I am preparing for my bath the water rushes from the faucet and I remember reading in the paper only a week or so ago

that even though the city water had a strange taste it was now being chemically purified and was perfectly safe to drink. Here is the soap, as white as a sheet of paper and of the well-known brand that floats—it certainly is a chemical triumph and one that has made an untold fortune for the manufacturer. I try to realize what processes were necessary in the preparation of the linoleum on the floor.

As I put on my clothing I notice that parts are bleached white by chemical agents while other parts have been colored by dyes which are purely chemical products. My shoes have been tanned with chemicals and as I polish them up a bit I realize that even the blacking is a chemical product. The rubber heels have been prepared by chemically treating the juice of a tree. I comb my hair with a comb of "chemical ivory." I don't consider myself a "jelly-bean," but I sometimes use a hair tonic to hold down my hair and give it a glossy effect and I realize that this liquid is a chemical preparation.

Going down stairs I get the morning paper which I carry to the breakfast table. On the front page is an account of the huge dirigible balloon, just completed by the government, which is being brought to Ft. Worth to be filled with helium. This is thirty miles from my home and is the only place in the world where this wonderful gas can be obtained in quantity. The newspaper has been prepared from wood pulp. The first time I heard that I laughed in derision and told my older brother he was "as crazy as he looked." However, that was a long time ago and so many things that have seemed impossible I have found to be true that now I will believe almost anything I am told. Our old negro cook says that the Bible tells her "great things will come to pass, so don't be surprised at nothing."

When breakfast is served I observe that chemistry has played its part there. The eggs are eggs, of course, but they have been fried in grease made from cotton seed. The bread has been prepared from flour which has been chemically whitened and from baking powder which is purely a chemical product.

Breakfast over, my teeth are brushed with a chemically prepared paste. I take my books and hurry to school. Here is more food for thought. The writing ink is a chemical product. The class books also owe much to the chemist though the printer usually gets the credit. The metal type, printer's ink, cloth back, binders glue, all were made possible through a knowledge of chemistry.

Classes come and go until finally it is the hour for chemistry. The teacher has arranged to take us to a doctor's office where we may see an X-ray machine in operation. Most of us are eager to see how such a machine is operated and a few are pleased only because they will get out of having a recitation. We not only learn what a marvelous thing the X-ray is—how by means of a chemical screen we can see our own hearts

beat—but the doctor takes time to explain many other things to us. First are the vaccines which furnish protection against various diseases. Other bottles we are told contain chemicals with which to fumigate after contagious diseases. Then there are the antiseptics for sterilizing wounds. On another shelf are the anti-toxins—the one for diptheria having saved so many lives. Surely the doctor is the worker of miracles today—but back of the doctor stands the chemist.

As it is past the dismissal hour we do not have to return to school. Several of us go over to the photographer's to get our pictures for the "Annual." At our request he allows us to come into the dark room and watch him develop a picture, washing it through different chemicals until finally on what was a blank surface appears the exact likeness of one of our class-mates. From there the "bunch" goes to a moving picture show. There we see first travel pictures of the Sphinx, Niagara Falls, our Pacific fleet and scenes from Japan and India, having circled the world in fifteen minutes. We next were shown a picture of President Wilson making his last public address on Armistice Day and the pictures of his funeral. A suggestion during my parents' childhood that one could have such events brought before him would have been considered an impossible, ridiculous fancy.

After dinner that evening my brother took me to a meeting of the Astronomical Society of which he is a member. There a university professor lectured and showed slides which demonstrated how the different elements are recognized by the kind of light they throw through a spectroscope. On the way home my brother talked of the innumerable discoveries that have been made and are being made every day.

Chemistry not only plays a large part in supplying the necessities of life but helps enrich our lives through books, music—so many people now enjoy the reproductions of the phonograph, through great art exhibits the marvelous colors of which the chemist prepares, through the stained glass windows of our great cathedrals, through marvelous tapestries, silks, metal cloths, the dyes and threads of which have been chemically prepared, through photography that brings us faces of those in distant cities and enables us to keep a likeness of our dear ones who have died. How our lives have been enriched by the biologist, horticulturist and physicist who are close kin to the chemist and have given us things too numerous to mention. Medicine has made possible the prevention and cure of diseases and chemistry is the foundation of medicine.

This slight glimpse of chemistry—a mere peep through the door into the wide vistas ahead—my course has given me. It has made me resolve to go on. It is not enough to know that chemistry plays a great part in so many processes. I must know just how that part is played.

It is not enough to fall down in dumb amazement as the medieval

knights did when the Connecticut Yankee struck a match and lighted his cigarette. I intend to learn how and why. It is not enough to listen to a lecturer tell that helium was found in the sun before it was found on our own earth. The adventures of the Connecticut Yankee are tame in comparison with my own adventures among the chemical miracles that are being performed every day to aid, beautify and enrich our lives.

PRIZE ESSAY STATE CHAIRMEN FOR 1925

Names and addresses of Chairmen of State Committees for American Chemical Society's Prize Essay Contest to whom school authorities should send essays for High and Secondary School Contest on or before March 1, 1925.

Victor H. Hanson, Birmingham News, Birmingham, Ala.

Dr. Cloyd H. Marvin, President, The University of Arizona, Tucson, Ariz.

G. W. Roark, Jr., 910 West 3rd St., Little Rock, Ark.

Will C. Wood, State Supt. of Public Instruction, Department of Education, Sacramento, Calif.

Dr. Wilbur D. Engle, Vice Chancellor, University of Denver, Denver, Colo.

Professor Treat B. Johnson, Department of Chemistry, Yale University, New Haven, Conn.

Chas. L. Reese, E. I. Du Pont de Nemours & Co., Wilmington, Del.

Wm. Knowles Cooper, General Secretary, The Young Men's Christian Association, 1736 G Street, Washington, D. C.

Dr. Townes R. Leigh, Department of Chemistry, University of Florida, Gainesville, Fla.

Dr. J. L. McGhee, Department of Chemistry, Emory University, Emory University, Ga.

Elizabeth Russum, State Supt. of Public Instruction, Department of Education, Boise, Idaho.

Thomas E. Wilson, President, Wilson & Co., Chicago, Ill.

Dr. C. B. Jordan, School of Pharmacy, Purdue University, Lafayette, Ind.

Dr. W. F. Coover, Department of Chemistry, Iowa State College, Ames, Ia.

Henry J. Allen, c/o "The Wichita Beacon," Wichita, Kans.

Dr. F. E. Tuttle, Department of Chemistry, University of Kentucky, Lexington, Ky.

Dr. H. W. Moseley, Department of Chemistry, The Tulane University of Louisiana, New Orleans, La.

Dr. C. A. Brautlecht, Department of Chemistry, University of Maine, Orono, Maine

Carl Haner, Supt., United States Industrial Chemical Co., Baltimore, Md.

Franklin W. Hobbs, President, Arlington Mills, 78 Chauncy St., Boston, Mass.

Frank O. Taylor, c/o Parke, Davis & Co., Detroit, Mich.

Dr. J. J. Willaman, Assoc. Professor of Agricultural Biochemistry, The University of Minnesota, University Farm, St. Paul, Minn.

Dr. John N. Swan, Department of Chemistry, University of Mississippi, University, Miss.

Edward Mallinckrodt, Jr., Vice Pres., Mallinckrodt Chemical Works., St. Louis, Mo.

Dr. W. M. Cobleigh, Department of Chemistry, The University of Montana, Bozeman, Mont.

Wm. M. Barr, Union Pacific System, Omaha, Neb.

Dr. Maxwell Adams, Vice President, University of Nevada, Reno, Nev.

Dr. Hugh K. Moore, Technical Director, Brown Company, Berlin, N. H.

Prof. R. G. Wright, Rutgers College and the State University of New Jersey, New Brunswick, N. J.

Dr. John D. Clark, Department of Chemistry, The State University of New Mexico, Albuquerque, N. Mex.

Dr. Nicholas Murray Butler, President, Columbia University, New York City

Professor I. F. Williams, North Carolina State College of Agriculture and Engineering, Raleigh, N. C.

Dr. G. A. Abbott, Department of Chemistry, The University of North Dakota, Grand Forks, N. D.

M. E. Danford, Works Mgr., The American Rolling Mill Co., Middletown, Ohio

E. E. Tourtellotte, President, Oklahoma School of Mines and Metallurgy, Wilburton, Okla.

J. A. Churchill, State Supt. of Public Instruction, Department of Education, Salem, Ore.

Milton Campbell, Pres. H. K. Mulford Company, Philadelphia, Pa.

Dr. W. H. P. Faunce, President, Brown University, Providence, R. I.

Dr. R. N. Brackett, Director, Department of Chemistry, The Clemson Agricultural College, Clemson College, S. C.

Dr. B. A. Dunbar, Department of Chemistry, South Dakota State College, Brookings, S. D.

Dr. H. A. Morgan, President, The University of Tennessee, Knoxville, Tenn.

Professor Harry B. Weiser, Department of Chemistry, The Rice Institute, Houston, Tex.

Dr. George Thomas, President, University of Utah, Salt Lake City, Utah

Dr. Paul D. Moody, President, Middlebury College, Middlebury, Vt.

Dr. Edwin A. Alderman, President, University of Virginia, University, Virginia

Worral Wilson, President, Seattle Title Trust Co., 114 Columbia St., Seattle, Wash.

George M. Ford, State Supt. of Free Schools, Department of Education, Charleston, W. Va.

Dr. J. H. Mathews, Department of Chemistry, The University of Wisconsin, Madison, Wis.

Lewis C. Tidball, Jr., Commissioner of Education, Department of Education, Cheyenne, Wyo.

CHEMISTRY IN THE SERVICE OF THE STATE

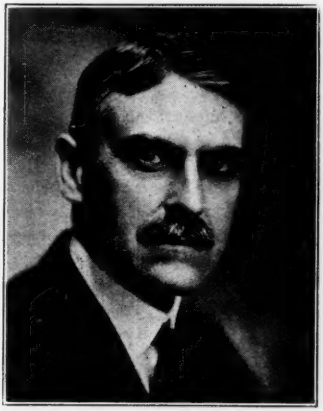
Chemistry Teachers should avail themselves of the bulletins put out by the Chemistry Department of the University of Wisconsin entitled "Chemistry in the Service of the State." A second edition of ten thousand has just been issued and will be sent free to any one desiring them as long as they last. Address Dr. J. H. Mathews, Head of Chemistry Department, University of Wisconsin, Madison, Wis.

CHEMISTRY IN THE FRENCH LYCEES*

WILLIAM FOSTER, PRINCETON UNIVERSITY, PRINCETON, N. J.

In order to appreciate fully the instruction given in Chemistry in the French *lycée*, one should know something of the French system of education and of the aims and ideals of their educators.

France has a most complete type of a state system of education, with a very strongly centralized administration of all grades; therefore, when a program for the teaching of chemistry is prepared and an order issued by the Minister of Education for the carrying out of the program, it applies to all the *lycées* of the nation. This means, of course, that the instruction is uniform. The term *lycée* is given to the academic secondary schools administered by the state.



William Foster
Professor of Inorganic Chemistry, Princeton University, Princeton, New Jersey

In the United States of America the secondary school is supplementary to the elementary school, neither offering a training complete in itself. In the organization of primary education in France the aim of it is expressed in an official report as follows: "We undertake the general culture of character and mind, but we seek at the same time to orient the child to practical life." In the higher primary school (*écoles primaires supérieures*) the aim is to continue education in this spirit up to the age of sixteen, in order to fit the scholar for an honorable place in the higher ranks of industry. Within certain limits the primary schools have aimed at general culture rather than purely technical or trade teaching, which is provided for by special schools (*écoles professionnelles*). In the higher primary schools, however, attention is given to "practical training of an educational character with special reference to the industries and circumstances of the locality:" *e. g.*, in a rural community special attention might be given to agriculture.

The academic secondary education is given in the *lycées*, which are first-grade schools maintained and controlled entirely by the state. The aim of these schools has been general culture; and the secondary education, unlike that in the United States, has been a training complete in itself.

* This outline is given according to the Programs contained in the Ministerial Order of December 23, 1923.

The course is seven years, consisting of six years named in sequence from Sixth to First and followed by a seventh year (the highest) in two sections, Philosophy and Mathematics.

Following is the outline of the instruction in Chemistry for the French lycées:*

This program is called the "Bérard program."

Second Grade (second year before preliminary baccalaureate examination).

Water, composition; hydrogen, oxygen.
Air, Lavoisier's experiment, nitrogen.
Electrolysis of sodium chloride; chlorine, sodium, sodium hydroxide.
Hydrochloric acid.
Analysis, synthesis, mixture, combination.
Elements: metalloids, metals; compounds.
Principle of the conservation of mass; law of constant proportions, law of volumes.
Symbols, atomic notation, formulas.
Sulphur, sulphurous anhydride, sulphuric anhydride, sulphuric acid, hydrosulphuric acid.
Nitric acid.
Ammonia.
Phosphoric acid, phosphorus.
Carboniferous bodies, carbon, carbon dioxide and carbon monoxide.

First Grade (year at the end of which the preliminary baccalaureate examination is taken.

Metals

Useful properties of metals and alloys.
Chloride and carbonate of sodium. Limestone, chalk, plaster.
Iron, cast-iron, steel, ferrous sulphate.
Aluminium; alumina, sulphate of aluminium, alum, isomorphism.
Zinc. Lead.
Copper and alloys, copper sulphate.
Properties of silver; properties of gold.

Organic Chemistry

Organized bodies. Organic substances.
Elements entering into an organic substance.
Hydrocarbons: Methane, petroleum. Ethylene. Acetylene. Illuminating gas. Benzene.
Ethyl alcohol; alcoholic fermentation.
Acetic acid; distillation of wood; vinegar, acetic fermentation.
General notions about: sucrose, glucose, starch, cellulose.

Philosophy Year (at the end of which the final baccalaureate examination in Philosophy is taken).

General Observations on Chemical Combination

Mixture and pure substances. Qualitative analysis.

* Translated from the French by Professor Percy A. Chapman, of the Department of Modern Languages, Princeton University, and by Professor William Foster, of the Department of Chemistry.

Laws of combination by weight and volume.
Brief notions of the system of atomic weights and molecular weights. Formulas. Valence.
Acids, bases, salts, Berthollet's laws.

Organic Chemistry

Principles of organic analysis. Synthesis: examples.
Behavior of substances in organic chemistry.
Brief study of a few substances from the point of view of behavior: ethyl alcohol, ordinary ether, acetic aldehyde, acetic acid.
Esters, ethyl chloride, fats: glycerine.
Benzine, carbolic acid, picric acid, aniline.

Mathematics Year (at the end of which the final baccalaureate examination in Science is taken).

General Observations on Chemical Combination

Qualitative analysis.
Principle of gravimetric and volumetric analysis (silver chloride, barium sulphate, acidimetry and alkalimetry).
Laws of combination by weight and volume.
System of proportional numbers. Chemical notation. Formulas.
Chemical definition of the system of molecular weights and atomic weights.
Physical laws which these weights obey: Avogadro, Raoult, Mitscherlich, Dulong and Petit. Application of these laws. Notion of valence.
Acids, bases, salts, Berthollet's laws.
Characteristics of oxides, sulphides, chlorides, sulphates, nitrates and carbonates.

Organic Chemistry

Principle of organic analysis. Synthesis: examples. Derivation of formulas.
Behavior of substances in organic chemistry (the behavior of each will be defined and studied in its place, from a particular example).
Hydrocarbons. Halogen derivatives: methyl chloride.
General study of ethyl alcohol from the point of view of its behavior. Ordinary ether, acetic aldehyde, acetone, methylamines.
General study of acetic acid from the point of view of its behavior: chloride and anhydride.
Esters.
General notions about the behavior of amides: urea. Cyanogen and hydrocyanic acid from the point of view of their behavior.
Glycerin. Fats, candles, soaps.
Benzene series of hydrocarbons. Carbolic acid (phenol), picric acid, aniline.

NOTE. In this class, a certain number of practical exercises will bear on a review of the more important questions of the programs of Second and First Grades.

At the beginning of the year, in this class, chemistry only will be taught for some time. Physics will be begun when the instructor in mathematics has ended the study of kinematics.

An examination of this program shows that the instruction in chemistry covers three years, the student advancing by easy stages from the simple to the more complex. Only a limited amount of material is included,

the idea being that it is better to learn some things well rather than to undertake to cover everything in the field of chemistry.

In the Second Grade (first year of the chemistry course and the fifth in the *lycée*) the number of topics studied is very limited indeed, for only a limited amount of time is devoted to the study of chemistry. Every young man in the *lycée* has to study physics and mathematics also. In the Second Grade the instruction has to do with such common things as water, hydrogen, oxygen, salt, etc. The study of carbon and carbon compounds is merely begun.

In the First Grade (second year of chemistry) the study of metals is taken up, attention being given particularly to useful properties of common metals and alloys. A few of the most important compounds of the metals are also studied, and the study of organic chemistry is continued.

At the end of the second year of chemistry the preliminary baccalaureate examination is taken.

The work of the Philosophy or Mathematics year follows. This corresponds, in general, to college work of American students after they have had a course in general chemistry. Some of the subjects studied are: qualitative analysis, physical and organic chemistry, and gravimetric and volumetric analysis. By the end of the *Mathematics year* the student is well grounded in the principles of chemistry and is qualified to do real university work. Indeed, the final baccalaureate examination in *Philosophy* or *Science* is taken.

The *lycées* lay great stress upon fundamental principles, but use plenty of material to illustrate these principles, so as to show the applications of chemistry. The program shows clearly that the French educators believe thoroughly in stressing *fundamental principles* so as to make the foundation broad and solid. The student must have something to apply before he can apply it.

NOTE. Owing to a change of ministry the general program, of which these regulations of chemistry are a part, is not yet in full effect. It makes clear, however, the principle upon which chemistry is taught in the *lycées*.

REPORT OF COMMITTEE OF CHEMICAL EDUCATION OF THE AMERICAN CHEMICAL SOCIETY

Since the Ithaca meeting of the American Chemical Society the Committee of Chemical Education has been giving considerable attention to organization of chemistry teachers. Local conditions have largely determined the form of these organizations. Some chemistry teachers have organized in connection with the local section of the A. C. S. The most perfect organization of this type is found at Chicago. Other chemistry

teachers have organized as a section of state teachers' associations. A fine example of this is found in the state of Wisconsin. There are some localities which have considered it best to organize as independent units. A most excellent organization of this kind is found at Washington D. C. To get details on these different types of organizations write the respective contributing editors as given on the inside front cover page of THIS JOURNAL.

The states already organized or having reported plans for organization are: Arkansas, California, Connecticut, Delaware, District of Columbia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

The Committee has reason to believe that the entire nation of chemistry teachers will be organized before the spring meeting of the Society with the possible exception of a few southern states where the chemistry teachers are too few and widely scattered to make organization feasible. Even in these states efforts are being made to get in touch with the chemistry teachers through THIS JOURNAL or otherwise, in order to be as helpful as possible to them.

The constitutions of the different organizations together with their recent activities bring out a variety of purposes. A few of them are:

1. To promote efficiency in the teaching of chemistry
2. To furnish a place for the study of reports and experiments in chemical education
3. To keep the teachers at the frontier in chemical education and pure chemical research
4. To help with the National Prize Essay Contest
5. To nominate contributing editors to THIS JOURNAL
6. To bring the chemistry teacher in closer touch with the Activities of the A. C. S. in general and the Division of Chemical Education of the A. C. S. in particular
7. To endeavor to keep all national problems taken up by the Committee of Chemical Education of the A. C. S. in tune with the local conditions
8. To keep the teacher in closer touch with opportunities
9. To furnish a common effort in any instituted reform
10. To invite lectures from industrial people and visit industrial plants in order to become more familiar with the practical side of chemistry.

It is expected that as soon as these organizations gain more experience, they will find many additional duties and privileges.

The committee wishes to take this opportunity to express its appreciation to these local organizations in helping with the project on the "Corre-

lation of High School and College Chemistry." It is planned that this piece of work will be temporarily finished by the Spring meeting of the Society. The committee say "temporarily" for it is realized that a subject advancing as fast as chemistry must have a dynamic outline, but any such dynamic project can always be easily and expediently handled through our national organization of chemistry teachers and this national Journal.

NEIL E. GORDON, *Chairman*
B. S. HOPKINS
L. W. MATTERN
L. C. NEWELL
R. E. ROSE
WALTER SCHMIDT
WILHELM SEGERBLOM
R. E. SWAIN
T. G. THOMPSON
F. W. WILLARD
F. B. WADE

THE FOUNDERS OF CHEMISTRY IN AMERICA*

LYMAN C. NEWELL, BOSTON UNIVERSITY, BOSTON, MASS.

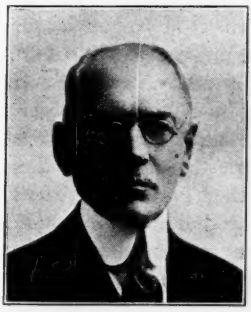
The **foundations** of chemistry in America were laid between 1775 and 1875. Progress was stimulated at first by Medical Schools and by scientific societies, *e. g.*, the American Philosophical Society (1743—still active) the Chemical Society of Philadelphia (1792—about 1809), and the American Academy of Arts and Sciences (1782—still active).

Chemistry was taught in the Philadelphia Medical School by Benjamin Rush as early as 1769. He was followed by Caspar Wistar, James Hutchinson, and John Garson. Soon after his arrival in America, Joseph Priestley was offered this position in 1794 but declined. James Woodhouse was appointed and held the place till his death in 1809. He was the first to lay broad foundations, being a teacher, author, investigator, and organizer. He wrote the first American laboratory manual—the "Young Chemists' Pocket Companion" (1797). Two of his students became famous—Robert Hare and Benjamin Silliman. In 1802, Woodhouse visited Europe, brought back an electric battery, and performed striking experiments with it. The battery interested Robert Hare, who subsequently invented two improvements. Woodhouse repeated Davy's experiments with nitrous oxide, studied the action of nitric acid on metals, analyzed many rocks, minerals, and ores, investigated the ways in which plants purify air, conducted a long series of experiments on the chemistry of flour and baking, devised a process for making fulminates, obtained potassium by heating soot and pearlash, and showed the superiority of anthracite coal over soft coal.

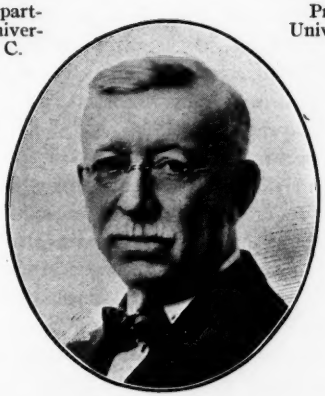
John Maclean was chosen Professor of Chemistry and Natural History in

* Abstract of a paper read Friday, February 8, 1924, at the one hundred and ninety first meeting of the Northeastern Section of the American Chemical Society.

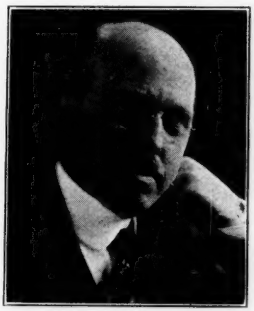
Geo. L. Coyle
Head of Chemistry Department, Georgetown University, Washington, D. C.



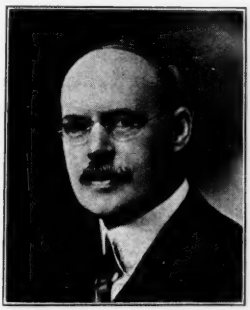
F. B. Dains
Professor of Chemistry, University of Kansas, Lawrence, Kan.



Edgar F. Smith
Professor Emeritus, University of Pennsylvania, Philadelphia, Pa.



Charles A. Brown
Chief Chemist, Bureau of Chemistry, Washington, D. C.



Lyman C. Newell
Professor of Chemistry, Boston University, Boston, Mass.

MEN WHO HAVE DONE MUCH FOR HISTORICAL CHEMISTRY IN AMERICA

Princeton University in 1795. For ten or twelve years Maclean gave lectures without a textbook but in 1808 adopted Henry's "Epitome of Chemistry," (edited with notes, by Benjamin Silliman).

In 1796 Woodhouse, Maclean, Mitchill of New York, and Adet, a French chemist of Philadelphia, became involved in a controversy with Priestley about the theory of phlogiston. Papers and replies were published for several years in the Medical Repository which was founded by Mitchill in 1797. Mitchill endeavored to reconcile the disputants by interpreting the results of each party—but to no avail. Priestley resented Mitchill's friendly interposition, and finally published a pamphlet—the last scientific article he wrote—entitled "The Doctrine of Phlogiston Established and that of the Composition of Water Refuted." Priestley was not convinced of his error, but the early founders of chemistry in America, especially Woodhouse, Maclean, and Mitchill, as well as Robert Hare and Benjamin Silliman, who had discreetly enjoyed the controversy from a distance, moved on with more confidence in a pathway which led them to enduring discoveries.

Samuel L. Mitchill was appointed professor of chemistry, natural history, and philosophy, in King's College, afterward Columbia College, in 1792. He was the first American to adopt and teach the French chemistry, and in 1794 he published an essay on the nomenclature of the new Chemistry, entitled "A Synopsis of Chemical Nomenclature and Arrangement." He was a teacher of power and ability, supplementing his lectures by experiments and by specimens, especially minerals, from a chemical museum established by him soon after he began his work at King's College. As a chemist Mitchill made contributions to the recurring problem of gunpowder, to soap making, to the use of certain chlorides as disinfectants, and to the disconcerting action of nitric acid on silver, copper, and tin. He published articles on the history of muriate of soda, on the rendering of ocean water fit for washing without the aid of soap, and on the salts in the Saratoga Springs water.

About 1800 chemistry in America was well on the way to definite and enthusiastic recognition. This was due to several facts. One was the simultaneous advent of two remarkable men—Robert Hare and Benjamin Silliman. Hare lived and worked in Philadelphia for about 70 years. He was Professor of Chemistry in the University of Pennsylvania for 30 years. Silliman lived and worked in New Haven about 70 years, 50 years being spent as Professor of Chemistry in Yale University. They began to study chemistry together as youths of the same age in Philadelphia in 1802, and continued their intimacy through their lives. Another fact was the establishment or extension of chemistry in institutions which have maintained unbroken instruction to the present day. At Harvard, Aaron Dexter began to teach chemistry in 1782 and finally secured an endowment

for a professorship of chemistry—the Erving professorship. At Dartmouth Nathan Smith started a medical school in 1798. At Bowdoin, Parker Cleaveland gave the first lectures in Chemistry in 1808, and continued for over 50 years. Instruction in chemistry as a specific subject began in Columbia in 1802 and in Yale in 1804. Within the next decade three other colleges began instruction.

Robert Hare was born in Philadelphia in 1781 and died there in 1858. He sent a communication in 1801 to the Chemical Society of Philadelphia, describing the discovery of the hydrostatic blowpipe, later called the compound or oxyhydrogen blowpipe. He invented in 1816 a powerful galvanic battery called the calorimotor and in 1820 another called a deflagrator. In 1818 he was elected Professor of Chemistry in the University of Pennsylvania where he remained until 1847. The American Academy of Arts and Sciences bestowed the Rumford Medal upon him in 1839—the first man to be thus honored. He contributed over 200 articles to Silliman's American Journal of Science, beginning in 1818 with the first issue.

Benjamin Silliman was born in North Stratford, Connecticut, in 1779, and died in New Haven in 1864 at the age of 85. In 1802 he was appointed Professor of Chemistry and Natural History in Yale University, not having studied chemistry, he obtained a list of books from John Maclean of Princeton, but his private reading was not fruitful. Hence during the winters of 1802–3 and 1803–4 he attended the lectures of James Woodhouse, though he learned more by studying with Robert Hare. In 1805, he took private lessons of Friedrich Accum in London. Upon returning to Yale, he resumed his teaching and continued until 1853. While in Philadelphia in 1802–3 and 1803–4, Silliman and Hare boarded at the same place. In his autobiography Silliman says: "We made use of a spare cellar kitchen in which we worked together in our hours of leisure from other pursuits. Mr. Hare had, one year before, perfected his beautiful invention of the oxyhydrogen blowpipe." In other places Silliman says: "His (Hare's) original experiments were repeated in 1802–3 in the presence of Priestley, Silliman, Woodhouse, and others. They were subsequently extended by Silliman, who. . .subjected a great number of refractory bodies to the action of the oxyhydrogen jet."

Hare also devised an apparatus which was probably the first electric furnace ever used. With this, or a similar furnace, he obtained calcium carbide, phosphorus, graphite and calcium.

Silliman made two fundamental contributions to chemistry in America—a journal and popular lectures. The American Journal of Science was started in 1818. For years Silliman patiently edited the journal and paid the annual deficit without complaint. Throughout most of his life, Silliman as publisher and editor kept the Journal going. Many well-known

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS

chemists helped him in the middle eighteen hundreds, *e. g.*, his son, Benjamin Silliman, Jr., Joseph P. Cooke, Jr., and Wolcott Gibbs. It is still published. Silliman began his popular lectures early in his career. He had rare qualification for this work. His lectures were thronged by intelligent and cultured audiences. In 1835 he lectured on geology in Boston. In 1839–40 he came to Boston to open the Lowell Institute. He gave several courses on Chemistry at the Institute.

Silliman took promising young men as private pupils and assistants into his laboratory. One of these was Oliver P. Hubbard, who went to Dartmouth in 1856, where he taught chemistry nearly 50 years. He also stimulated a dormant interest in chemistry in young men by his popular lectures and experiments. One of the lads so aroused was Josiah P. Cooke, Jr.

At Harvard University, Aaron Dexter (1750–1829), was Professor of Chemistry and Materia Medica in the Medical School from 1783 to 1816. John Gorham (1783–1829) succeeded Aaron Dexter and was Erving Professor of Chemistry from 1816 to 1827.

In 1827 John W. Webster was made Professor of Chemistry and Mineralogy, a position which he held until 1849—a short time before his death. Professor Webster confined his instruction to the Medical School, except toward the end of his term of service. Then he gave two or three chemical lectures to the undergraduates of the College "which were brought to a sudden end by his show experiment called the volcano." This was the position of Chemistry in Harvard University up to the time just preceding 1850.

Josiah P. Cooke was a member of Professor Webster's "Volcano class"—in which he learned no chemistry. He graduated from Harvard University in 1848 and returned after a year's study in Europe.

In ten years, despite opposition, Professor Cooke introduced a new subject into Harvard College, built up courses, erected and equipped a building for lectures and laboratory work, and secured the respect of his colleagues and the confidence of the administration. Among his first laboratory assistants were Frank H. Storer and Charles W. Eliot.

Mr. Eliot continued to study at Harvard and took his A.M. in 1856. He studied with Professor Cooke up to 1858, and remained at the College, an Assistant Professor up to 1863. He studied chemistry in Europe from 1863–65.

Francis H. Storer received his B.S. from the Lawrence Scientific School in 1855. From 1855–57 he studied chemistry in Europe. When the Massachusetts Institute of Technology opened in 1865, Storer and Eliot were among its professors. When they began their work in the Institute, the laboratory was a small poorly equipped room in the second story of a mercantile building on Summer Street, nearly opposite the store of

C. F. Hovey and Company. There were no laboratory manuals in chemistry suited to the policy of President Rogers and to the plan of his two zealous professors. So they wrote one in general chemistry and the other in qualitative analysis, which set the standard for other institutions.

Professor Eliot resigned in 1869 to become President of Harvard College, and Professor Storer left the Institute in 1870 to become Professor of Agriculture at the Bussey Institution, a recently organized School of Agriculture and Horticulture.

On August 1, 1874, American chemists gathered at the old home of Priestley in Northumberland, Pa., to celebrate the centennial of the discovery of oxygen. One result of this meeting was the founding of the American Chemical Society in 1876.

THE OBJECTIVES OF HIGH SCHOOL CHEMISTRY

J. O. FRANK, STATE NORMAL SCHOOL, OSKOSH, WISCONSIN

It is surprising that so many critics of high school chemistry instruction should make the claim that chemistry teachers are often unable to give a clear account of what they are trying to do. In view of the abundance of material dealing with the aims and objectives of high school chemistry, and the close agreement of the various authorities on the subject, it hardly seems possible that there could be any considerable number of chemistry teachers who really fail to understand the true nature of the job of chemistry teaching. Yet such a claim is often made.

With the thought that there may be teachers who would appreciate a summing up, and perhaps also a *clearing up* of the various expressions of the aims and objectives of high school chemistry, several of the most authoritative sources have been consulted,* and the following summary of aims and objectives prepared:

* Inglis, "Principles of Secondary Education."
Bagley, "Educational Values."
Eickenberry, "Teaching of General Science."
Bulletin 35, 1918, "Cardinal Principles of Secondary Education."
Bulletin 26, 1920, "Reorganization of Science in Secondary Schools."
Caldwell, "Science Teaching in the Gary Schools."
Report of Committee on Education, American Chemical Society.
Powers, "A Diagnostic Study of the Subject Matter of High School Chemistry."

I. Instruction

All authorities agree that we want to *instruct* our pupils. Many teachers will admit that they once conceived of teaching as wholly a question of

instruction and we only have to go back a few decades when most school boards expected a teacher to have but two qualifications: first, that he know more than the pupils he was to instruct; and second, that he be able to maintain discipline. Back in the days of the "storage" idea of education, with the accompanying principle of "formal discipline" and the "transfer of training" was born the thought that *teaching* consisted wholly of *imparting knowledge* and *training the mind.* Today, imparting knowledge is a small part of the job.

Undoubtedly, so far as chemistry is concerned, teaching will always mean that the student is to be left with that great mass of facts, rules, laws, principles and concepts, which we always associate with the subject. Much of this will be purely a question of memory learning of the subject matter of the textbook. But getting pupils to *comprehend ideas*, to think chemistry in terms of the systematic organization of the subject matter, and the fusion of all the facts, laws, principles, and concepts, together with their innumerable applications into a complete subject, will be the main job of the teacher.

II. Training

It seems clear that chemistry as a high school subject is expected to give the pupil a rather well defined training. It is to leave him with certain skills, certain abilities and certain habits, which are peculiar to the subject and the operations and manipulations which belong to it.

It is expected that a pupil in the course of his work in high school chemistry will acquire habits of accuracy, of neatness and order; habits of concentration and of finishing work begun; habits of study and of economy in time and materials; and last but not least important, every pupil should be freed from habits that are detrimental, such as habits of shiftlessness, inattention and lack of aim and foresight. This is a part of what we call *training*, but only a part.

Training also includes the development of certain skills, such as skill in manipulation of apparatus, in reading directions, in planning work to be done, and in studying by the most effective methods. We might instruct a boy in all those facts and principles which are involved in the riding of a bicycle, but the boy would never learn to ride a bicycle on instructions alone. He has to have actual experience before he is actually able to ride. The same may be said about learning to swim, learning to speak French, or learning to do analytical work in chemistry. Instruction is absolutely necessary, but training must go with it, if the necessary skills and habits are to be acquired. Training alone can produce that *confidence in science* which is so necessary to science and society.

III. Inspiration

In high school chemistry it seems desirable to establish certain ideals and appreciations which must necessarily go with attainments in science if science is to advance the welfare of society, ideals of devotion to duty and loyalty to truth; ideal of self sacrifice and of the highest types of altruism; an appreciative understanding of the service of chemistry to the state, to the nation, to society; and a respect for that nobility of spirit which makes men labor and sacrifice for the welfare of others.

The history of science gives us such names as Galileo, Copernicus, Pallisy, Scheele, Darwin, Pasteur and many others, who, by years of hard work, by sacrifice of worldly goods, by sheer determination and steadfastness of purpose, or by actual martyrdom have made great contribution to the advancement of human welfare.

Teachers must use the stories of the lives and labors of these men to inspire their pupils and to leave the germ of a desire to imitate their best qualities, if the future generations of scientific men are to make science the instrument of progress and enlightenment it has been in the past.

IV. Discipline

High school chemistry, when properly taught, should establish with its pupils definite ideals of method and procedure. When these ideals become fixed as standards to be lived up to, they serve as safeguards against poor and inefficient work. The methods of science, once thoroughly understood through frequent use, should produce an attitude of mind making for stableness of judgement in situations similar to those of the science class room, and if science has been made practical, if illustrations and applications have been selected from every-day life and simple apparatus used, the scientific method will be functional in every-day life.

It is necessary to establish a sense of fairness and caution, which brings an attitude of mind which craves accuracy and exactness, a willingness to hear both sides of a question, and to wait for *all* the facts. Not only a willingness to hear all the facts, but a state of mind that *demands* all the facts. This discipline which can come only from drill, from scientific labor and experience, together with a hunger for truth, is today a necessity where the welfare of a nation rests on the ability of the common people to see and to *think*.

V. Power to Interpret

Man still labors under many of the handicaps placed upon him by his past history. He is the victim of inherited superstitions, fears, prejudices and instincts which disturb his daily life and warp his judgement in many ways. The scientific method of reasoning, and the scientific attitude of

mind once really acquired through scientific training, should leave an individual disciplined against these primitive tendencies, a man with a new interpretative power—a stable, dependable and consistent individual upon whose judgement questions of national importance may be safely trusted.

We still have gargoyles on our buildings to scare away the evil spirits. We often see amber beads worn to prevent goiter and a sack of asafetida to prevent measles. We still hear of charms to cure warts and men are known to carry buckeyes to prevent rheumatism and a rabbit's foot to ward off bad luck. The patent medicine almanac is still printed by the millions for those who plant their crops by the phases of the moon, because they are the very people who fall prey to the quack with his nostrum, just as they do to the primitive fears and superstitions handed down from past ages.

It is still bad luck to kill a cat, to begin a journey on Friday, or break a mirror, and the number thirteen is shunned by nearly every one. Auto licenses bearing the number thirteen or some combination of it are frequently refused by motorists. We still tell of the stork that brings babies, of the Easter rabbit and relate to our children stories of animals that talk, and we still celebrate hallowe'en night with all sorts of pranks. Our laws and our customs still teem with ideas and notions that have no place in our time, but which we have been unable to lose, and which still influence our lives.

Our science should be so taught that it would leave our pupils with the ability to pick the false from the true, to cast away prejudices and superstitions and be ruled by reason only. A pupil with a scientific training should be able to let the intellect replace the emotions in influencing his decisions.

Coulter says that the hope of a democracy lies in the education of every man so that he is free from superstition and fear of the unknown, so that he examines things for himself with understanding, weighs the facts and draws correct conclusions. Such men will not fall prey to quacks with false cures for physical ills, nor to demigogues with false remedies for political ills. The big thing is to make a part of the mental make-up of the pupil a consciousness of the invariability of cause and effect, and a confident understanding that natural laws always function.

Science teaching, especially chemistry teaching, can and should produce these attitudes, perspectives and disciplines which are so necessary for the maintenance of a sound and safe citizenry in a democracy such as ours.

VI. Exploration and Guidance

A course in high school chemistry should be to every student like a newly discovered gate into a beautiful and unexplored garden, a never-

ending romance with something ever more interesting just around the corner. The variety of experience offered by chemistry should serve to point out to the pupil the direction of his interests and abilities. Thus, science has an exploratory aim. It should find abilities and inclinations and develop them to the highest possible level.

VII. Recreation

Chemistry teaching should produce a store of tastes and appreciations which should be an inexhaustible source of recreation and pleasure. The individual with a true understanding of chemistry will perceive a new beauty in nearly everything around him. He will see in the ugly piece of coal all the beautiful colors of the aniline dyes; in the ill-smelling sewage the fertile fields that it can produce; and in the poison of the plant the specific for a dangerous disease. The very processes and operations of chemistry will come to be a source of pleasure and its accomplishments a cause for pride—if the student has gained all those tastes and appreciations that should be gained from a good course in high school chemistry. A good course in chemistry should leave the pupil with a strong desire to go further with the subject.

In attempting to set down in actual words the things that chemistry teaching should accomplish, I have no doubt left out things which one teacher believes to be important, and put emphasis on what another thinks relatively insignificant. I have offered my interpretation of the job of high school chemistry teaching with the thought that it might serve as a basis for further discussion.

THE CINDERELLA OF THE METALS*

M. ELIZABETH FARSON, HAMILTON SCHOOL, CHICAGO, ILL.

The Cinderella of the Metals is a chemistry play based on "group one" of the Periodic Table. It was presented by the fourth grade pupils of the Hamilton School, Chicago, Illinois. The names of the pupils who gave the play are given in the following cast:

CAST

Characters	*Names of Players*	*Age*
Lithium	Marjorie Thomas	9
Sodium	Lillian Miller	9
Potassium	Frank Sterba	10
Copper	Martha Pickett	10

* The name of the play was suggested by the incident of the discovery of the beauty of some copper discovered among the ashes of a fire in which it had been melted.

Characters	*Names of Players*	*Age*
Rubidium	Harold Lund	10
Silver	Clara Pellieci	9
Caesium	Oscar Madl	10
Gold	Myrtle Falk	9
Radium (In group two)	Elsie Wade	9

The characters all enter, make curtsy, and announce their names. Sodium announces the name of the play:

THE CINDERELLA OF THE METALS

The costumes represent either the spectra, or the natural color of the various elements.

Gold—A delicate golden-haired child who is beautiful, but conceited. Costume is a short full dress made of gold paper, a crown of gold.

Silver—(Gold's sister). A vivacious sturdy child who can assume an aristocratic air. Dress of silver paper made in form of petals sewed on a white underslip.

Copper—(Step-sister of Gold and Silver). This character should express unselfishness, service, and joy. An auburn-haired type is best suited for this character. Dark brown crepe paper dress trimmed with green, representing malachite.

Lithium—(King's Messenger). A small, active child, one light on his feet. Messenger's costume made of pink sateen.

Potassium—(Prince). A serious, thoughtful child. A purple cape, gold crown.

Caesium—(Butler). Butler's costume of blue sateen to represent a line in spectrum of Caesium.

Rubidium—(Butler). Butler's costume of red sateen, to represent red line in spectrum.

Sodium—(Chaperon). A haughty, animated child, silvery white paper dress.

Radium—(Fairy God-mother). A bright, attractive child, blond type, whose movements are light and graceful. Fairy costume of white gauze, gauzy wings and a wand.

ACT I

Time, Noon-day. Place, Home of a rich family.

Scene, Richly furnished sitting-room with an old-fashioned grate.

(The two pretty sisters, Gold and Silver, admiring themselves in the mirror. Sodium overhears their conversation and hurries into the room.)

Sodium (In an irritated manner)—"Oh, girls, vain, vain girls! Stop admiring yourselves in the mirror! You will become ugly, if you look into the mirror so often." (She takes mirror away from girls.)

Gold (In much astonisment rushing over to Sodium and taking her hand)—"Sodium, don't you realize that I am the most beautiful and one of the most valuable metals in the whole world?"

Sodium (Looking at Gold tenderly)—"Yes, Gold, I do, but really you would make me happier if you were as useful as you are beautiful." (Sodium puts her arm around Silver who is pouting.) "What is the trouble with Silver?"

Silver (With a great show of indignation)—"I know that I am not as pretty as Gold, but I know more about the world than Gold. Just think, I have traveled all the way from dark far away Russia." (Silver tosses her head and laughs.)

Gold (Scornfully)—"Silver, I am afraid that you have forgotten that I came from the Paradise of the World, California." (She bows elaborately, eyes twinkling with glee.)

Sodium (Interrupting sternly)—"Please don't argue about your beauty and your knowledge, girls. Oh, here comes you new step-sister." (Copper, the step-sister, enters stretching out her hands as she smiles sweetly.)

Gold and Silver—"Oh, isn't she ugly?"

Silver—"What is your name?"

Copper (Sadly)—"My name is Copper."

Gold and Silver (Sneeringly)—"Copper! What a queer name!" (They laugh.)

Gold (Walking toward Copper)—"Where did you live before this?"

Copper (Trembling)—"I came from the far off land of Cyprus."

Sodium (Emphasizing with forefinger)—"Copper, attend to the fire! That will be your work. Ignorant girl! I will show you how to make a fire in the grate." (Sodium seems to catch fire. Copper rushes to her aid.)

Silver—"Look! Look at the beautiful yellow flame! Sodium is burning." (Both girls become terrified and scream.)

Sodium (Putting more wood on the fire)—"Don't be frightened, girls." (Holding up two strips of yellow paper.) "These are the double yellow lines in my spectrum. These lines show that Sodium is found in the sun."

Gold—"Oh, that is the reason for the yellow flames."

Gold (Motioning for quiet)—"Listen!"

(Voice calls out)—"Message from Prince Potassium."

Silver (Joyfully)—"Oh, come right in Lithium." (Lithium, the King's messenger, enters.)

All (Cry out)—"Welcome, Lithium, welcome!"

Sodium (Scornfully)—"Lithium, I have been told that you are the lightest solid known."

Lithium (Gleefully)—"You are right. That is the very reason the King chose me for his messenger, because I am so light." (Hands Sodium an invitation.)

Sodium (Reading note aloud)—"You and your charming proteges are invited to attend the ball, Signed, Prince Potassium." (Girls skip around delightedly.) "Won't it be glorious! Come, girls, we must have our gowns made ready at once!" (Great excitement.)

Gold (Boastfully, stepping to center of stage and facing audience)—"I am going to have the prettiest gown so that the Prince will dance with me."

Silver—"Gold, don't be too sure. I think the Prince will dance with me."

Sodium (Throwing back her head proudly.)—"Nonsense, girls, the Prince is going to dance with me." (All leave the room laughing.)

(Girls and Sodium soon re-enter room beautifully gowned and find Copper working at the fire.)

Copper—"Please let me go with you to the ball."

Sodium—"In that dark ragged dress? Never! You must have a suitable dress as Gold and Silver have."

Copper—"I would rather be dressed as I am than like Gold, because Gold's attractive appearance has caused trouble and sadness in the world."

Gold (Rushing up to Copper)—"Never mind, Copper. I am told that an evil spirit dwells within you. Go! Attend to your fire!"

Copper—"I have tried to be of service to all the world, so I am glad to be of service to you now." (Returns to fire-place. Others turn up their noses at Copper.)

Sodium—"Come, girls, or we will be late for the ball." (Exit.)

Copper (Sitting at the fire weeping)—"Oh, if I could only go to the ball!" (Pointing excitedly to the dark rear of the stage)—"What is that bright light which I see over in the dark corner? It is coming nearer and nearer. Oh, it is Radium!" (Radium steps forward.) "My fairy God-mother."

Radium (Lovingly)—"Copper, I have come to help you."

Copper (Enthusiastically)—"Radium, you have the power to make sick people well and ugly people beautiful. Won't you make me beautiful?" (Reaches out her arms imploringly.)

(Radium touches Copper with her wand. A beautiful colored light plays over Copper.) (A transmutation scene.)

Radium—"Copper, I have transformed you. You are now beautiful."

Copper (Kneeling before Radium)—"I bow to the power of Radium, and may you have more power in the years to come." (Radium retires.)

CURTAIN

ACT II

Scene at the ball

(Prince Potassium and two butlers, Rubidium and Caesium, enter. The Prince walks about.)

Potassium (Thoughtfully)—"Tonight is the night of all nights. I suppose Sodium and her charming proteges, Gold and Silver, will soon arrive."
Rubidium (Announcing)—"Sodium, Gold and Silver are coming." (He goes to meet them. Sodium, Gold and Silver enter and are introduced.)
Potassium—"How charming you all look this evening."
Caesium—"An unknown metal has arrived."
Potassium—"Even though she be unknown, tell her to enter." (Copper enters.)
Everyone exclaims—"Oh, how beautiful!"
Potassium (Gallantly steps forward and greets her)—"So, you are the unknown one. Pray tell me your name."
Copper—"I am sorry, but I cannot tell you my name."
Potassium—"May I ask the name of your birthplace?"
Copper—"Long, long ago I came from Cyprus."
Potassium (Happily)—"Oh, I know you. You are Copper."
Gold and Silver—"Copper! Our own step-sister!"

(Potassium ignores everybody else and lavishes attention on Copper.)

Sodium, Gold and Silver (Very much insulted by the Prince's actions)—"Prince Potassium, we beg leave to go. Good-night." (They hurriedly leave the ball room.)
Prince Potassium (Joyously to Copper)—"To me you are the most beautiful metal present because you are so willing to serve the world. Therefore, I will bestow the honor upon you of dancing with the Prince."
Copper (Smiling radiantly)—"Every Metal has its day."

CURTAIN

CHEMICAL RESEARCH IN NATIONAL PREPAREDNESS

HENRY B. FABER, MAJOR ORDNANCE O. R. C.

It is in the hope that many students in the universities of our country will take an interest in the many problems of a technical nature that are offered in the development of our plans for National Preparedness that this article is written.

No other country in the world today has as excellent a plan for an army for National Defense as the United States of America. With a small

Standing Army, a National Guard, and a Reserve Officers Corps closely interwoven and coördinating as a unit, we are fortunate in being able to translate ideals into practical performance.

If there is one National trait that stands out clearly, it is the spirit of coöperation. The World War proved beyond a doubt that the American people would sacrifice themselves in almost any effort which would help the Government during the time of stress. At the present time we have no need for the heroic effort made during the days of the War; but there are many problems of a technical nature which have yet to be answered, and there are many minds capable of working out and solving these difficulties, which minds should be directed to this end. The technical research students in the many universities are peculiarly fitted to engage in the solving of many of these problems.

Many a man would like to give a part of his time to the service of his country in time of peace, but does not know how his efforts can be used to advantage. This is particularly true of the student who is both able and willing to serve if his energies were properly directed.

The War Department is confronted with more technical problems requiring careful research than they are able to develop with the thoroughness they would like. The universities have an army of men eager for work of a constructive nature and opportunity for research far beyond the present means at the command of the War Department.

It is suggested that the universities and colleges of the country give such of their research students as desire, the opportunity to do their thesis work on problems suggested by the War Department.

Many universities are doing this very thing today and it is in the hope that others will follow that this suggestion is made.

HELPING THE METRIC CAMPAIGN

EUGENE C. BINGHAM

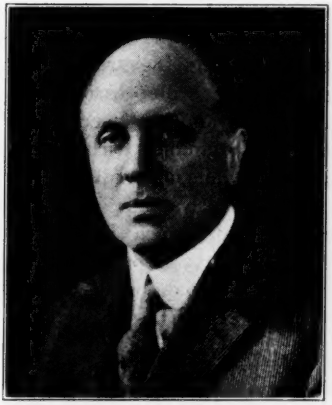
Chairman of the Metric Committee of the American Chemical Society, Lafayette College, Easton, Pa.

Several teachers have written to the American Chemical Society for information in regard to the Metric System. Most of them are placing the material made available in the hands of students who are preparing papers on the subject. This movement is very much worth-while for there is a surprising lack of information on the Metric System. This may be proved by a few striking examples.

The National Education Association recently advocated taking the teaching of the Metric System out of the curriculum of the schools. The

Metric System is legal in all of the nations of the world and compulsory in all but the United States and Great Britain. It is used here in foreign trade, in electricity, chemistry, physics, biology, medicine and to a growing extent, in domestic trade and industry. Instead of taking the metric system *out* of the schools, it should be taught more effectively, so as to show the tremendous waste involved in the use of our present nondescript units. Let us teach looking toward doing away with the whole English System of weights and measures and the virtual abolishment of the use of vulgar fractions which go with the English System. Educating people to order by tens ("dizens" shall we say), instead of twelves (dozens) would be a tremendous saving in the bookkeeping of the nation.

Those opposed to the metric system have raised objections which to the initiated seem childish in their naïveté, yet we must assume that their objections are honestly held. They claim that with the transition to the metric system, everything will have to be changed to confirm to the new measurements, including our houses, railroads, ships and all machines. They imagine that an inch pipe, for example, is really an inch in diameter (which is not the case) and that on going to the metric system it must become a centimeter in diameter or some simple multiple of a centimeter. The only alternative which these opponents present is that of converting simple inches into exceedingly complex metric equivalents.

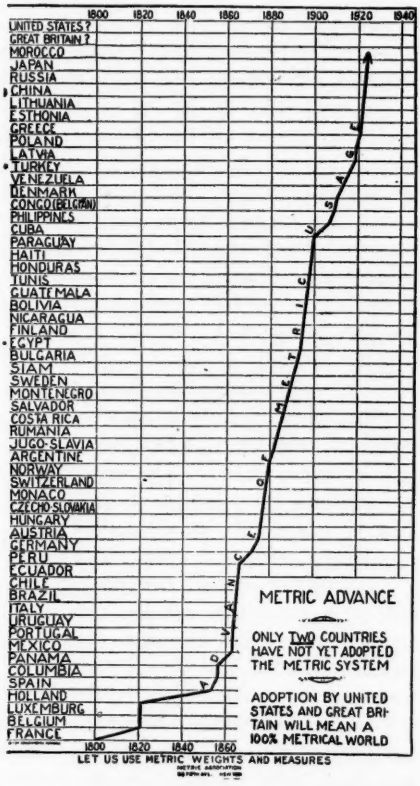


Eugene C. Bingham

Head of Chemistry Department, Lafayette College, Easton, Pa.

As a matter of fact the *present* situation is extremely complex, so that an inch pipe is not the same thing as an inch tube, and it is not the same for brass as for iron and in no case can one be sure that either the inner or outer dimension is an exact inch without looking it up in a handbook. When it comes to gauges of wires and sheet metal the numbers are rather arbitrary and there are a variety of gauges so that the use of the metric system in which the number would represent the exact diameter of the wire or bar or tube irrespective of its material would be a great advantage. However, in industry there are certain tolerances so that simplicity can always be obtained. The uninitiated may suppose that since a meter is equal to 39.37 inches and an inch therefore is represented by a continuing decimal it is necessary to represent the metric equivalents of our customary

dimensions by inconvenient fractions. Such is not the case. It is rare for more than four significant figures to be used in industry and often three suffice. In the metric drawings of a shop all of the dimensions may be represented in millimeters, so no names of units need appear and no vulgar fractions whatever, giving a very clean appearance to the drawings. Legislation toward the compulsory use of the metric system would affect the buying and selling of commodities, but not the actual sizes of the articles of commerce. The cost of the change would be largely in connection with our measuring devices and many of these would not have to be scrapped since they could often be regraduated at an almost nominal cost.



As to the use of conversion tables during the transition period, they will occasionally be needed and the mechanic is already familiar with their use even while nominally using the English System. The division of the inch into sixteenths, thirty-seconds, sixty-fourths and so on breaks down when we reach the present day precision extending to one millionth of an inch in the best gauges, so the mechanic is using more and more decimal fractions of an inch along with the vulgar fractions. Hence he has before him conversion tables. He is familiar with the fact, for example, that $^1/_{64}$" = 0.015625 inch. This is as inconvenient as the metric conversion factors which may occasionally be required but the mechanic uses them without the outside world learning of his difficulties. That the country could make the change without any great difficulty of any kind has been amply proved by numerous industrial concerns which have found it advantageous to make the change and by whole countries, many of whom are highly industrialized like ourselves, *e. g.*, Germany, France, Belgium, Italy and Japan.

There has been an assumption that the transition from the English system to the decimal system would be attended with large expense, delays and mistakes, so that when the American Chemical Society asked American Chemists to order their pure reagent chemicals in "Standard Metric Packages" there was considerable skepticism. It was claimed that dealers would charge more and give inferior service. However, the manufacturers and dealers have admirably met all of the desires of the American Chemists. Several firms today sell their pure chemicals only in "Standard Metric Packages" and practically all of the most reputable houses print catalogs with metric quantities and complaint has disappeared. There is no delay or increase in cost.

At first it was argued that chemicals are put up in special bottles made on the avoirdupois bases in very expensive molds and that metric quantities being one-tenth larger than avoirdupois could not be used. But chemicals vary so widely in specific gravity that all sizes of bottles are needed anyway, so that the difficulty is of no importance. This is merely typical of all of the arguments which are raised against the metric system.

Another example may be added for good measure from outside the chemical field. It is said that with the advent of the metric system all of our lathes will have to be discarded. Not only is this not true, but with the addition of *one* wheel having 127 teeth any standard American lathe can cut metric threads, when they are needed.

Chemists use the metric system by preference, even carrying it over into manufacturing to great advantage in certain instances. By buying chemicals and apparatus according to metric specifications and dispensing them similarly to students and publishing all experimental results in metric equivalents, it is believed that there is offered to the general public a demonstration that the metric system is thoroughly practical and that its adoption will be attended by no hardships whatever.

The bibliography includes recent articles and books representing both sides of the question, hoping that interest may thereby be stimulated.

1. Report of Metric Committee, Eugene C. Bingham. *J. Ind. Eng. Chem.*, **13**, 401 (1921).

2. Adoption by Colleges of Standard Metric Units, Eugene C. Bingham. *J. Ind. Eng. Chem.*, **13**, 1068 (1921).

3. Progress in Metric Standardization, Eugene C. Bingham. *J. Ind. Eng. Chem.*, **14**, 332 (1922).

4. To Consumers of Pure Chemicals, Eugene C. Bingham. *Ind. & Eng. Chem.*, **15**, 849 (1923).

5. Editorial—A Step Backward. *Ind. & Eng. Chem., News Ed.*, **1**, 4 (1923), 17, Sept. 10.

6. Metric System Dropped from U. S. P. H. Spec. for Drugs, Anon. *Ind. & Eng. Chem., News Ed.*, **1**, 2 (1923), 17, Sept. 10.

7. Opposition to the Metric System, S. S. Dale. *Ind. & Eng. Chem., News Ed.*, **1**, 5 (1923), 19, Oct. 10.

8. Answering Mr. Dale on the Metric System, Eugene C. Bingham. *Ind. & Eng. Chem., News Ed.*, **1**, 5 (1923), 20, Oct. 20.

9. Editorial—Metric System Pro and Con. *Ind. & Eng. Chem., News Ed.*, **1**, 4 (1923), 20, Oct. 20.

10. Russia Adopts Metric System, Anon. *Ind. & Eng. Chem., News Ed.*, **2**, 5 (1924), 2, Jan. 20.

11. Where to Get Chemicals in Metric Packages, Anon. *Ind. & Eng. Chem., News Ed.*, **2**, 2 (1924), 7, April 10.

12. The Metric System in Medicine, Eugene C. Bingham. *Ind. & Eng. Chem., News Ed.*, **2**, 3 (1924), 8, April 20.

13. Chemicals in Metric Packages, Anon. *Ind. & Eng. Chem., News Ed.*, **2**, 6 (1924), 10, May 20.

14. Purveyors of Standard Metric Chemicals, Anon. *Ind. & Eng. Chem., News Ed.*, **2**, 6 (1924), 6, June 10.

15. Progress in Metric Standardization, Eugene C. Bingham. *Science*, **55**, 232 (1922).

16. Conference on World Metric Standardization, W. V. Bingham. *Science*, **56**, 362 (1922).

17. The United States Fundamental Standards of Length and Mass, T. C. Mendenhall. *Science*, **56**, 377 (1922).

18. The Metric Campaign, Howard Richards. *Science*, **55**, 515 (1922).

19. Are Scientists Encouraging Popular Ignorance? Eugene C. Bingham. *Science*, **55**, 664 (1922).

20. Metric Weights and Measures (Gives tables of conversion) The Metric Assoc., 156 Fifth Ave., New York, N. Y.

21. History of Standard Weights and Measures of United States, L. A. Fischer. U. S. Bureau of Standards Scientific Paper, 17, *Bull.*, **1**, 365 (1905).

22. *The Decimal Educator*, Published monthly by the Decimal Assoc., 229 Finsbury Pavement House, London, E. C. 2.

23. Metric Manual for Soldiers, Miscellaneous Publication, 21, Dept. of Commerce, Bureau of Standards (1918).

24. The International Metric System of Weights and Measures. U. S. Bureau of Standards (1906).

25. Units of Weight and Measure, Definitions and Tables of Equivalents. *Circular*, 47, U. S. Bureau of Standards (1914).

26. Annual Reports. The Metric Association, 156 Fifth Ave., New York City.

27. Miscellaneous Publications. The World Metric Standardization Council, 681 Market St., San Francisco, Cal.

28. How Big is an Acre? Alexander McAdie. *The Atlantic Monthly*, **134**, 78 (1924).

29. World Metric Standardization an Urgent Issue, **1922**, $5.00. World Standardization Co., 681 Market St., San Francisco, Cal.

30. Metric System for Engineers Clapham, **1922**, $6.00. E. P. Dutton Co., New York.

31. The Metric *vs.* the English System of Weights and Measures, **1921**, National Industrial Conference Board, Century Co.

32. The Metric Fallacy, Halsey, **1920**, $2.00. Am. Inst. Weights and Measures, 115 Broadway, New York City. Assoc. formed in opposition to the Metric Assoc.

33. Evolution of Weights and Measures, Hallock and Wade, The Macmillan Co.

34. Metric Literature Clues. A List of 700 References to Books, Pamphlets, Documents and Magazine Articles on Metric Standardization of Weights and Measures, Clifton Hildebrand, World Trade Club, 681 Market St., San Francisco, Cal.

35. Progrès du Système Métrique, C. E. Guillaume, International Bureau of Weights and Measures, Paris.

36. Drachms, Scruples and King's Noses, Alexander McAdie. *The Atlantic Monthly*, **134**, 820 (1924).

IMPORTANCE OF TEACHING CHEMISTRY*

CHARLES E. MUNROE, PROFESSOR OF CHEMISTRY AND DEAN OF FACULTY OF GRADUATE STUDIES, EMERITUS, GEORGE WASHINGTON UNIVERSITY

We have met tonight to perfect the organization of the District of Columbia Association of Chemistry Teachers, and it is a happy coincidence that this meeting falls in "Education Week," which has been dedicated to such purposes by our President. It may interest you to look over this copy of President Coolidge's Proclamation as issued by the State Department, which I present to you. It augurs well for the success of this Society that it is being organized on so auspicious an occasion, and that so large a portion of the teachers of chemistry of the District of Columbia should have responded to the call for the meeting. I esteem it a special honor to have been invited to address you at so important an event in the development of the teaching of chemistry in the locality in which I have spent so large a portion of my life.

During some thirty years, on the occasion of my first meeting with the incoming Freshman Class at the George Washington University, I addressed the class on "Why Study Chemistry,"** pointing out that chemistry as a study may be pursued, (1) for its economic value; that is as furnishing a means of livelihood; (2) to enlarge one's vocabulary; (3) as a means of culture; (4) as a means for improving the condition of mankind by ameliorating his environment; (5) because we are completely subject to its laws and our lives depend, during every moment of our existence upon the orderly progress of the many chemical reactions going on within, and without, our bodies, and also because every commercial transaction in which we may take part, except barter, is based upon a chemical analysis; and, (6) one may study chemistry from patriotic motives, hoping to serve the nation's needs both in peace and war. Each of these topics was enlarged upon and illustrated as the time at command, and character of the audience permitted and warranted. Reviewing, in my mind, this address, it appears to present as forcibly "The Importance of Teaching Chemistry," as it did the advantages accruing from the study of chemistry.

Though in my discourse on the above topic, I pointed out how especially suitable the study of chemistry was in the development of leadership and administrative capacities, I did not dwell, as I should, on its tendency to

* Address presented on the occasion of the organization of the District of Columbia Association of Chemistry Teachers, Nov. 20, 1924.

** *Am. J. Pharm.*, Dec. 1923, and *School Sci. & Math.*, **24**, 134–144, Feb. 1924.

develop the truly judicial mind, meaning by this the open mind; the tolerant mind; the reasonable mind. A mind, which takes all available facts and conditions into consideration in reaching a conclusion, but which makes that conclusion binding only until other newly discovered evidence modifies this, or points to another conclusion.

This is inevitable for what the human finite chemist seeks is exact and complete knowledge of the infinite, phrased in terms within his comprehension. This can only be, and has only been, gained by gradual approach. Chemistry is in a continual state of flux, new facts, new data, new points of view, new theories, being continually developed to modify and replace the old. This is recognized by the "International Committee on Atomic Weights" in dating its "Tables," and by those who use this data when they too supply the date of this information, as all should. To cultivate this tolerant attitude all teachers of chemistry should impress it upon their students that while chemistry consists of an enormous assemblage of data, descriptive matter, and theories, all are to be regarded as but approximations to the truth, and that the true chemist stands ready at any time to accept changes in data and descriptions, and modifications in theories, when sufficient evidence is adduced.

That this is the proper attitude for the chemist to take may be impressively shown by the History of Chemistry, and this constitutes a reason why such history should be made a part of every course in chemistry, apart from the fact that it comprises many thrilling episodes and much of human interest. Personally, I am of the opinion that the historical matter should be introduced little by little throughout a course, the better to enliven the topic, hold the student's interest and fix the attitude sought. With history I include biography, so that the student may know something of the masters, other than their names, and realize that they were human and fallible as we are. Thus, when dealing with the Periodic Tables, one may properly and profitably introduce some brief characterizations of Chancourtois, Newlands, Mendelejeff and Lothar Meyer, for instance. When dealing with atomic weights, or masses, one might, among others, make brief mention of Berzelius, Proust, Dumas, Stas, Crookes and Richards. And, so for every topic which is the subject of chemical study, there will, as you present it, rise in your mind the names of many of those to whom we are indebted for such information as is recorded on that subject.

As one follows the history of chemistry, he is impressed with the continued increase in the rate at which chemical knowledge increases, and particularly the applications of this acquired knowledge to the benefit and development of mankind. This alone is sufficient to signalize "The Importance of Teaching Chemistry" for it is essential to the community that there should exist in its midst a body of teachers capable of compre-

hending, and accurately gauging the importance and significance of new discoveries, determinations, characteristics, relations, and applications; the development of new hypotheses and theories; and, the verifications which tend to transfer theories to the category of laws—which body of teachers should also be competent to present the new material in such a manner as to be assimulated by the novice in fairly accurate and intelligent form, or at least to such an extent that he may be able to apply properly what is immediately available to improve his condition.

There are many ways in which this acceleration in the rate of accumulation of chemical knowledge may be visualized. In his address on "The Biggest Things in Chemistry," Dr. Willis R. Whitney* presents the following:

> Chemistry is one of those branches of human knowledge which has built itself upon methods and instruments by which truth can presumably be determined. It has survived and grown because all its precepts and principles can be re-tested at any time and anywhere. So long as it remained the mysterious alchemy by which a few devotees, by devious and dubious means, presumed to change baser metals into gold, it did not flourish, but when it dealt with the fact that 56 g. of fine iron, when heated with 32 g. of flowers of sulfur, generated extra heat and gave exactly 88 g. of an entirely new substance, then additional steps could be taken by anyone. Scientific research in chemistry, since the birth of the balance and the thermometer, has been a steady growth of test and observation. It has disclosed a finite number of elementary reagents composing an infinite universe, and it is devoted to their interreaction for the benefit of mankind. The rate of this advance in chemistry is in our day almost incredibly great.
>
> Mark Twain's little history game has given me a view of our rate of development, and particularly of modern as compared with ancient affairs, that I want to pass along to you. Possibly some of you have thought of the rate of mental development, of material development, and of power developments as involving only a fairly uniform change through all time. This is not so at all. But to shorten this story: I started from a certain point in the woods with a measuring tape and marking tools, and laid out a winding path 1000 feet long. I cut smooth marking places on all trees along the way and on some large rocks. I appropriated one foot length of this patch for each year's history since William the Conqueror (the year 1000), and spent the rest of my time properly locating prominent events along the path, down to 1920 feet. I was impressed by the 45-ft. length of Queen Elizabeth's reign, near the middle of the way, and a short distance from Columbus and the discovery of America. Stockings and pins and sugar (except as medicine) came into the path about there. But of interest to us particularly is that all the great chemists began to arrive together near the 1850-ft point. This seemed very recent. It meant that most of the superstitions about matter began to disappear only about 250-ft. back, so to speak. You all know the story, but for 75 or 80 per cent of my measured patch, and for the interminable portion representing all time prior to 1000 A. D. (which I let wind, without construction or destruction, back the mile or more which might still have been historically illustrated), there had been no need for more than four supposed elements; earth, air, fire, and water. It was not the old facts, but the dimensions which impressed me. While a foot is ample space in which to erect monuments to everything we know about any year chosen in the 15th century, and a single tree could be sign-post for all the cards on events for any century a little

* *J. Ind. Eng. Chem.*, **13**, 161–166 (Feb. 1921).

earlier, there was great lack of space for descriptive matter beyond the 1800-ft. point. All down the line, to within a stone's throw of the end, individual man-power had been the important energy, and then, as power, it almost disappeared. Within 200-ft. of the end, which stood for the present day, steam had been put to use, and there came in turn the myriads of machines which multiplied a thousand-fold the previous constant and limited muscular power of man. No one can accurately determine the added spread of effort, due to the substitution of coal for human strength, and then of machines, one after another.

Within 30 feet of the end of the path, a score of new chemistries had grown into activity, and every single one seems more promising than the original stem; physical, colloidal, subatomic and radio, metabolic, biologic, enzymic, piezo, therapeutic—all growing infants. Thus the time seems almost near when, to quote Carnegie, "the mind, like the body, can be moved from the shade into the sunshine."

This interesting game of Mark Twain's actually chokes itself off mechanically when one tries to post modern chemical work at one foot per year. New facts now take about that space when posted edgewise in abstract journals, a dozen items per page. What this game, applied to chemistry, has done for me is to show me the almost inconceivably great strides in countless lines which constitute our modern chemistry, and it leaves me with the feeling that no one in the world has ever had such possibilities open to him as the present-day student of chemistry.

It would appear that Whitney's application to chemistry of Mark Twain's method for graphically visualizing historical development might well be made use of by teachers of chemistry in stimulating an interest in this science. The data for use in plotting such diagrams is abundant but scattered through the literature. It is to be found in many text-books, sometimes tabulated as in Barker's Chemistry; Handbooks, such as Biedermann's Chemiker Kalender, list such events; "Nature" runs in each issue a list of the most significant events in the records of the Royal Society; Dictionaries such as Watts, Wurtz and Thorpe will furnish a wealth of material. The game ought to prove as fascinating as a chemical spelling bee, or as cross-word puzzles. It ought to present such novelty and produce such competition that chemistry may offer to the youthful mind an equal appeal with radio. No one could make such a search as this sport would necessitate without being insensibly led to read a lot about matters which casually attract attention as the searcher turns the pages. As this reading is voluntary the subject is likely to hold the attention of the student and kindle his interest.

The development of chemistry has in recent times been marked by the formation of organized bodies of chemists. There is hardly one such recorded earlier than the beginning of the 19th century. Now each of the more civilized nations possesses not one, but several. The American Chemical Society, with an enrollment of over 14,500 members, was founded in 1876. I had seen a quarter of century of life and was in the active practice of my profession when I joined in the founding of this Society and, in common with my associates, I have been amazed at its growth, yet this appears to be but an earnest of the future, for we learn from *Chemical &*

Metallurgical Engineering for Nov. 17, 1924, that the National Industrial Conference Board, which has, from the viewpoint of our basic industries, been investigating the requirements as to men needed for executive, administrative and technical positions, finds that in 1930 American industry, as a whole, will need 400,000 more persons to fill these positions than were required in 1920. Recalling how very profitable for the stockholders, and how beneficial to the earning capacities of the corporations Germany has shown it to be, to place chemists in executive and administrative positions, and recalling the continually increasing importance chemistry is to all industries, the needs of this vast body makes "The Importance of Teaching Chemistry" still more apparent.

The growth of chemistry in industry may be shown by charts such as those before you. It fell to my lot to serve as Expert Special Agent in charge of "Chemicals and Allied Products" at the U. S. censuses of 1900, 1905 and 1910, and on these copies of maps of the United States, before you, there is recorded, by suitable characters, the location of each factory reported at the census as producing "sulphuric, nitric and mixed acids," "explosives" or "fertilizers." A comparison shows a material extension of the industries in 1910 over 1905, but what most arouses attention is that these industries are so localized and limited, and that the larger part of our vast country yet awaits chemical development. It would appear that we have as yet just started and that a great future must be prepared for by the teacher of chemistry. Let me suggest that charts of the kind such as these prepared for each census, beginning with 1900, would prove most useful to teacher, student and manufacturer.

In dealing with the topic assigned me let me impress on you the fact that teachers of chemistry are especially preparing students for entrance into that profession in which is today enrolled the largest body of thoroughly educated men engaged in any one of the professions and which is growing faster than other professions. As evidence of this we have, among other records the following:

Annually for some years, Miss Hull of the National Research Council has collated and discussed the statistics for "Doctorate Degrees conferred in the Arts and Sciences by American Universities." In her report for 1922–1923, she presents a table of all doctorate degrees conferred in each year from 1914 to 1923 inclusive, from which it is seen that, judged by the number of doctorate degrees conferred, Chemistry is more widely cultivated, and more frequently selected as the subject of study and research, than any other topic offered in our Universities. For each of the years enumerated, it has stood at the top of the list of the 37 topics which have been made the subject of graduate study. Each year the number receiving doctorate degrees in chemistry have not only greatly exceeded the number receiving degrees in any other subject, but, in most years, they have been

nearly double the number of those receiving degrees in the next most cultivated subject. Taking 1923 as an example, we find the doctorate degrees conferred to be in Chemistry 181, Education 74, Botany 64, Physics 54, History 54, English 53, Psychology 46, Zoölogy 45, Geology 35, Economics 34, Bacteriology 32, Romance Languages 29, Mathematics 28, Philosophy 27, Political Science 24, Pathology 21, Physiology 20, Sociology 18, Theology 13, Latin 12, Greek 11, Agriculture 10, Anatomy 10. In no other of any of the remaining 14 subjects of study were as many as ten degrees conferred. In his recent survey Zanetti found there were 1700 students of chemistry engaged in research work in the United States in 1924. The chemist is a force to be counted with and professionally he must stand by himself though his knowledge is of service to all others.

A COÖPERATIVE PLAN IN CHEMICAL EDUCATION

NEIL E. GORDON, UNIVERSITY OF MARYLAND, COLLEGE PARK, MD.

At the University of Maryland a coöperative experiment is being tried in Chemical Education where the chemical industries are helping the boy to get some practical chemical experience while taking his college course in chemistry. The experiment has started off so well, that the author feels justified in bringing it to the attention of other teachers for their consideration. In brief, it is a scheme where students are enabled to take a standard college course in four years and at the same time get one year's experience in practical work. This is made possible by the student utilizing his summers either in work or study. The following diagrammatical illustration will show how the student's time is proportioned.

PROPORTIONMENT OF A STUDENT'S FOUR-YEAR COLLEGE CAREER

	First year		First summer		Second year	
Time	1st sem. Sept. 15 to Feb. 1	2nd sem. Feb. 1 to June 15	June 15 to Aug. 15	Aug. 15 to Sept. 15	1st sem. Sept. 15 to Feb. 1	2nd sem. Feb. 1 to June 15
Occupation	Study	Study	Study	Vacation	Study	Study
Credit Hours	15	15	8		18	18

	Second summer	Third year		Third summer		Fourth year	
Time	June 15 to Sept. 15	1st sem. Sept. 15 to Feb. 1	2nd sem. Feb. 1 to June 15	June 15 to Sept. 1	Sept. 1 to Sept. 15	1st sem. Sept. 15 to Feb. 1	2nd sem. Feb. 1 to June 15
Occupation	Work	Study	Work	Study	Vacation	Work	Study
Credit Hours		18		10			18

It will be noted that the credit hours total 120 which fulfills the standard requirement in an Art and Science College, and that this is done without taking over 18 hours any semester. Since the coöperation

with the industries does not begin until the second year, most of the student's work in departments other than the chemistry department has been completed. On the other hand if these subordinate courses have not been finished, no difficulty arises, for all shifts come at the usual break period (that is June 15th, or Feb. 1st). It may be further noted by the diagram that while a junior is studying, a senior is working and vice versa. In this way the job is continually manned, and each boy gets one year of experience during his last two years in college.

Some advantages which the plan offers to the student are the following:

1. Utilizes his summers along lines which are in tune with his life work
2. Gives the student an outlook upon a practical field while studying, and helps him to see the need of acquiring chemical knowledge
3. Brings him in contact with the practical men of the country and hence helps him to get a vision of the practical side of our science
4. Acts as a vocational guidance, *i. e.*, he knows at the end of four years whether or not he wishes to be a chemist. If he decides in the negative he has had a four years' course which will equal any in fitting him for the battles of life
5. He will usually be placed at the end of four years, for he has had a chance to show his worth to some one who needs a man
6. He earns sufficient money to nearly pay his expenses during his last two years in college

It must be acknowledged that the advantages of the plan to the industries does not equal the advantages to the student, yet these are, at least two:

1. The industries have a chance to "size up" a man without obligating themselves in any way.
2. As a rule these college-trained men fill the subordinate positions more efficiently than the man commonly hired for these positions. They are better trained and enthusiastic to "make good" and have a future ahead of them, while many times these positions are filled by men who are quite satisfied with life.

Curricula are being worked out where the plan may be tried in all phases of chemical education.

BALTIMORE MEETING OF THE A. C. S.

Plan for the Baltimore Meeting. You cannot afford to miss it. Many fine papers have already been submitted for the Meeting of the Division of Chemical Education. If you have papers which you feel would be of value to your fellow workers, send them at once to B. S. Hopkins, University of Illinois, Urbana, Ill.

Chemical Digest

1924 IN RETROSPECT

D. H. KILLEFFER, 19 E. 24TH ST., NEW YORK CITY

In looking back over the year just ended, several things stand out in rather bold relief against a background of general mediocrity. The year has been one of very few outstanding scientific achievements, yet one of active development in a commercial sense. Its beginning saw the United States firmly entrenched behind an efficient tariff barrier, business in all lines reasonably active and profits of such proportions as to permit the exploitation of ideas and discoveries which were already definite parts of the knowledge of the chemical industry. Research in pure science was continued throughout the year but few startling or epoch-making announcements were made in this field. In general it may be characterized as a period of successful commercial development in many lines.

D. H. Killeffer
Assoc. Editor Industrial and Engineering Chemistry, 19 E. 24th St., New York City.

Perhaps the most important scientific announcement of the year was that of the actual synthesis of a sugar by Prof. E. C. C. Baly of the University of Liverpool. By the use of ultra-violet light, Prof. Baly succeeded in producing, first, a highly active kind of formaldehyde from carbon dioxide and water, and, later, by starting with ordinary formaldehyde he was able to make a material which Principal Irvine of St. Andrew's University, Glasgow, found to contain a sugar closely related to, if not identical with ordinary glucose. The importance of this accomplishment and of the theories advanced to explain it cannot be overestimated from a scientific point of view, but in spite of the fears and hopes of some few sanguine individuals there is no commercial development of the process yet possible and there seem to be grounds for the belief that there never will be. However, one cannot refrain from allowing one's imagination to look into the future when it may be possible for mankind to supply its own food by doing in the laboratory those things which the green leaves of plants have done for us for so many uncounted centuries.

The secret of this has been the use of ultra-violet light as a method of supplying energy to the reaction in quantities far greater than those which it has been possible to apply to any reaction by other means.

The immense quantity of energy consumed by the reaction of carbon dioxide and water to form the active formaldehyde is of the order of 150,000 calories per gram which is to be compared to a few hundred calories per gram required or given off in the reactions with which the chemist ordinarily deals. It is in the cost of such staggering amounts of energy that the present, and possibly the future, impracticability of such a process lies.

In connection with ultra-violet light investigations, another series of results attained in the laboratory and announced during the past year call for consideration. Rickets, the disease of the bones which affects so many children in our slums, particularly, was found some time ago to be curable by proper exposure of the sufferers to sunlight and later it was discovered to be curable, as might be expected, by exposing the sufferers to ultra-violet radiation. The result of this was somewhat of an upset of the theories previously advanced by nutritional experts to explain the disease on the basis of vitamin deficiency, but not nearly so serious a one as came with the announcements made this year. Dr. Hess of New York and Dr. Steenbock of Wisconsin, independently announced during the year that they had found it possible to cure pronounced cases of rickets in animals by merely exposing the *food* of the animals to ultra-violet radiation. Such things as oils which ordinarily possessed no curative properties became remarkably efficient in curing rickets after they had been exposed to ultra-violet radiation, and the theories of the disease are completely upset. The questions which are puzzling those most interested in these things are whether a vitamin, in the accepted sense of the word, has been created by the action of the radiation, whether some action akin to that obtained by Prof. Baly has occurred in this case, and finally whether the whole subject of vitamins may not be much more nearly related to energy values than it is given credit for being.

To offset any particularly radical departure in this direction, we have the announcement by Dr. Eddy and his associates working at Columbia University that they have isolated a chemical individual in crystalline form which has all of the properties of the so-called vitamin D or bios. Undoubtedly there is much evidence and there will be more to support either the catalytic or the energetic theory of vitamin action and it is reasonable to presume that the ultimate result will be a theory which will take into account both possibilities.

We have said before that the year's developments have been most largely commercial. Perhaps the most important of these has been the commercialization of insulin. From a laboratory product of a year or so ago which was painfully made by a few individuals and intrusted to a chosen few of the medical profession for administration under constant

supervision, insulin has progressed to the point where one of our large life insurance companies notes an actual reduction in the number of deaths from diabetes and hazards the guess that insulin may possibly be responsible. It is most gratifying to note the rapidity with which this development has taken place and the efficiency with which the material is being applied to the relief of human suffering.

Two efforts to conserve the supply of motor fuel have been in effect during the past year on scales sufficiently large to warrant their consideration here. One of these has directed itself to the conservation of material produced from our wells and the other attacks the problem from the angle of increasing the efficiency of utilization of fuel in the motor itself. Both of these fields have seemed to offer possibilities in the direction of conservation and results already achieved seem to indicate that the possibilities are fast becoming realities.

In the production of the so-called "natural gasoline" by the liquefaction of the heavier constituents of the natural gas which occurs in great quantities in and near the petroleum fields, the process in use has consisted of simply compressing and cooling the gas in the presence of some absorbent such as a heavier oil or activated carbon, and the subsequent distillation and condensation of the absorbed portion of the gas. The resulting material consists of a mixture of the various hydrocarbons of low boiling points and in its original condition possesses too high a vapor pressure to be usable. The practice in the trade was to run this material into a tank car, setting the safety valve of the car at the desired vapor pressure and allow it to stand until a sufficient quantity of the lowest boiling constituents had boiled away at atmospheric temperature to make it safe to use. The result was the loss of about half the volume of the gasoline produced. To offset this loss, which naturally included a considerable proportion of the higher boiling valuable constituents, an efficient fractionating column was introduced and a clean separation of the desired from the undesired parts was obtained. The production of natural gasoline amounts to some 1000 millions of gallons annually and it has been estimated that the apparently obvious expedient of introducing the proper fractionating system throughout the manufacture of this valuable material would result in a saving of one third of the total. Not only is it possible to save valuable gasoline constituents in this way, but uses are being found for at least a part of the waste gases, ethane, methane, propane and so on. In a similar way the development of cracking processes, by which it is possible to produce greater volumes of gasoline from a given amount of crude oil, has progressed in a most satisfactory manner and although there has been no really startling development in this field during the period under consideration it is interesting to note that while crude oil yielded only 12.5 per cent of its volume as gasoline according

to the practice of 1913, the practice of 1923 (the last year of which complete records are now available) yielded 30 per cent of the volume of crude oil as gasoline.

Two methods of increasing the efficiency of internal combustion motors have been commercialized during the past year. One has been put out simply as a preventive of knocking and a remover of deposited carbon. It consists essentially of a solution of a nitro compound in a suitable solvent. While there are many claims of increased efficiency from the use of such a material, the evidence offered so far to support them lacks the dignity of scientific accuracy, and while there is undoubtedly some merit in such a compound it is hardly to be compared with tetra ethyl lead in the results attained. Tetra ethyl lead, which has been marketed during the past year in commercial quantities for the first time, offers far greater possibilities in increasing the efficiency of the utilization of fuel in internal combustion engines. So far the full value of it has not been realized in practice for the reason that the motors at present in use will not permit it. The ordinary internal combustion engine operates under a compression of some thirty to forty pounds per square inch, and if this compression is increased to any extent when the engine is operated on ordinary gasoline, the engine begins to knock badly and its efficiency is reduced instead of increased. However, the addition of very small amounts of tetra ethyl lead to the fuel prevents knocking and permits the use of compressions considerably higher than those at present practicable and thus permits a very decided increase in efficiency. When it is considered that the energy in one gallon of gasoline is sufficient to run an ordinary Ford automobile a distance of 480 miles over level paved road, the possibilities in the matter of increasing engine efficiency become evident. While results so far obtained in increased motor efficiency are only preliminary, yet it is obvious that this method of stretching out our dwindling petroleum reserves is of increasing importance.

Two occurrences in connection with tetra ethyl lead must be given consideration here. It is manufactured by the use of bromine compounds. Under ordinary circumstances the consumption of bromine and of bromine compounds in the world is a rather limited affair and production is adjusted to meet this normal demand. When manufacture of tetra ethyl lead by a process using bromine was begun, there developed a more or less serious shortage of this element and its compounds and prices in all markets rose rapidly. At the present writing these high prices and the shortage of bromine and bromides are continuing. Indeed at the figures reached (partly of course through speculative interest and partly on the basis of the actual need for them) they have come near being prohibitive to this new industry. Hence it was sought to find a process by which chlorine could be utilized instead, and finally one was found which seemed to offer

possibilities from an industrial point of view. However, during the development of this process, a most regrettable accident occurred which caused much consternation and much fanatical discussion in the public press. Some thirty-five men working in the production of the material by the new process were seriously poisoned, five of them fatally, presumably by tetra ethyl lead. Immediately, Boards of Health busied themselves in considering whether or not they should prohibit the use in their respective states of gasoline containing tetra ethyl lead, and actually two states have put laws into effect prohibiting it even though the product sold to the automobilist contains less than one tenth of one per cent of tetra ethyl lead and seems to be perfectly innocuous. Certainly there is no justification for such prohibitive action as has been taken on insufficient evidence. Indeed there is a great mass of evidence in the hands of the manufacturers of tetra ethyl lead, including reports of investigations of the Bureau of Mines, the Chemical Warfare Service and others, which tend to show that no greater danger attends its use in gasoline than attends that of ordinary gasoline. What the ultimate outcome of the various investigations still in progress will be cannot now be definitely foreseen, but it certainly is safe to say that the value of tetra ethyl lead in conserving gasoline is such as to warrant every possible effort on the part of its manufacturers to make it safe to use, if it is not so already.

The use of mercury vapor in turbines as a source of power has been put to the very severe test of commercial practice during the past year, and although the proponents of the idea do not even claim that all the problems in connection with it have yet been solved, preliminary results covering the operation of such a unit for a year are most satisfactory. The principle upon which this development is based, is in the increased efficiency of a heat engine operating over a wider range of temperature than that possible with steam alone. A direct heated boiler furnishes mercury vapor, at a temperature of 812° F. and a pressure of 35 pounds per square inch, to a turbine which exhausts at 29 inches of vacuum and 414° F. This exhaust is used to boil water and furnish steam for further use. In this way the entire cycle operates at an over-all efficiency much greater than could be obtained with steam alone.

Clear quartz glass has been made commercially for the first time during 1924. The remarkable optical properties of quartz, and its low coefficient of thermal expansion make it extremely valuable for many purposes, but advantage could not be taken of these until it was possible to make a glass of it free from bubbles. From the present commercial product it is possible to make rods, plates, lenses and countless other desirable objects. Its clarity is such that 93% of the light passed into one end of a rod a meter long will be emitted from the other. Its most valuable

property is perhaps its ability to transmit invisible light both in the ultraviolet and the infra red ends of the spectrum. Its low coefficient of thermal expansion ($^1/_{17}$th of that of platinum and $^1/_{34}$th of that of copper) make it extremely valuable for lenses and mirrors used in astronomical observations for the reason that changes of temperature do not distort them to any disadvantageous extent.

While work has been continued on the construction of the Wilson Dam at Muscle Shoals, much discussion of its final disposition has been carried on. From those who have wanted to put this immense power to work have come more or less extravagant promises of cheap concentrated fertilizers for the farmers and other benefits without number. At present there are several offers before Congress for utilizing this project for the good of the country, but in spite of discussions extending through almost the entire long session of Congress no disposition has yet been made of it. The offer of Henry Ford, which contained the most extravagant appeal to the farmers, has been withdrawn even though the House had accepted it. That Muscle Shoals can and should be utilized cannot be gainsaid, but the hope of cheap concentrated fertilizers held out to the farmers by Mr. Ford, especially, can hardly be expected to materialize whatever the final disposition of the property may be. Investigations by the Department of Commerce through its special representatives have resulted in the publication of several bulletins on the world nitrogen situation, which in the final analysis show that the utilization of so vast a power as that at Muscle Shoals for the sole production of nitrogenous fertilizer would be foolhardy at the present time. Another statement bearing upon this point comes from the Department of Agriculture, whose experts admit that even were concentrated fertilizers made, no one—not even they themselves and particularly not the farmers—would be able to utilize them without risking serious damage to crops.

The way in which the development of a tank car for carrying liquid chlorine safely has seriously affected the market for bleaching powder and has largely revolutionized methods in bleacheries deserves notice. Bleaching powder as it enters commerce has an oxidizing power equivalent to 35 to 37% of available chlorine, the remaining 65 to 63% being inert matter. In shipping this over long distances the freight on so great a weight of inert matter was a serious factor, and so it was sought to find a way to ship liquid chlorine. To do this it was necessary to ship it in heavy containers and the result was a balance between the two with slight odds in favor of the bleaching powder. Tank cars for conveying the liquid chlorine were built after the customary practice and these did reduce the freight charges very considerably on account of the fact that the railroads haul cars gratis, charging only on their contents. How-

ever, in addition to the danger of damage to a container holding so great an amount of chlorine, the serious difficulty arose that few consumers were able to use an entire tank car load of material without so delaying the car for unloading that demurrage charges ate up the possible profits from the operation. In this state of affairs, a tank car was devised which consisted of fifteen one ton tanks mounted removably on a car in such a way as to form an integral part of it. This met the railroads' specifications as a tank car, reduced the hazard in handling to a minimum, and permitted the consumer to unload the car in a very short time by simply removing the full tanks and replacing them by empties. This brought on early in the year a serious price war between the makers of liquid chlorine and of bleaching powder which threatened the extermination of the latter for a time. However, as matters have turned out, the present buying season is providing a sufficient amount of business for both to restore at least an armed truce.

This review cannot be concluded without reference to the many questionable enterprises which have come to light during the year. Perhaps the most serious of these have been aimed at the danger from carbon monoxide poisoning from automobiles run in closed garages. In this field every kind of device from a type of muffler which magically sorts out the carbon monoxide molecules from the exhaust gases and imprisons them, to a paint for use on the walls of the garage possessing similar magical properties has been foisted upon an unsuspecting and more or less fearful public. Cure-alls designed to restore youth, health and vigor to the aged and infirm have been exploited in such a way that it has been impossible for the general public to distinguish between the charlatans and the earnest workers whose results occasionally lead one to believe that there may yet be a possibility of such things in reality. "Universities" conducted by mail from small and easily movable offices have come in for serious and effective attention in many cases, but there are still a great many of such luring money from the unwary and giving little or nothing of value in return. Fake stock promoters are always with us and there is reason to believe that many of this ilk operated with great profit to themselves in the boom days of the stock market which followed closely after the election of President Coolidge.

The era of prosperity upon which the country entered after the elections in the Fall has brought a goodly share of prosperity to the chemical industry. Reports from all lines are very favorable and particularly from those which are ordinarily considered the barometers of the industry, sulfuric acid and soda. At no time during its life has this industry looked forward to a year which held so much promise of profitable legitimate business, as distinct from the highly speculative days of the war period, as does 1925.

ABSTRACTS

Noise of Electrons Heard by Human Ears. The smallest thing in the universe has made a noise and man has listened to it. Scientists have previously discovered and measured the electron but today Dr. A. W. Hull of the General Electric Company's research laboratory and Dr. N. H. Williams of the University of Michigan reported to the American Physical Society meeting here that they have been successful in listening by radio to movements of electrons, the smallest particles of matter.

Using a vacuum tube radio amplifier, magnifying the sound a hundred-thousand fold, the rain-like blows of many electrons on the plate of the tube produced a roar that sounded like Niagara in the distance. The sound is caused by bombardment of the plate by electrons, released from the hot filament. It is these electrons which carry the current and which make the operation of the tube possible. Dr. Hull, therefore, believes the noise is a fundamental property of electron emission, a characteristic of the electron. The noise, due to the electrical oscillation which is set up by the impacts of the individual electrons on the plate, is known as the Schrot effect and was predicted on the theoretical grounds by Dr. Schottky of Berlin.

Listening to the electrons was merely incidental to more technical researches undertaken by Drs. Hull and Williams. They were primarily engaged in measuring the electrical charge on the electron.

This was first accomplished with great accuracy by Dr. R. A. Millikan of the California Institute of Technology at Pasadena and winner of the Nobel Prize for physics last year. Drs. Hull and Williams were attempting to obtain the same results by a method differing from that used by Dr. Millikan.

Dr. Millikan's method of measuring the charge of an electron is based on the influence of gravity and of electric charges on minute oil "droplets." These droplets are so small that the effect of gravity causes them to fall only a quarter of an inch in ten seconds—they are about three hundred-thousandths of an inch in diameter and are observed in a powerful beam of light with a small telescope. They are then seen as specks of light against a dark background.

In the formation of these small drops with an atomizer, occasionally one becomes charged by friction; that is, it may carry an additional electron. If then the droplet is between two electrically charged plates it will behave differently from the uncharged particles, Dr. Hull stated. Those which are not charged will fall. The charged particles will be attracted to the positive plate. By the use of the proper voltage between the plates, these charged particles can be made to fall more slowly, held stationary, or caused to move upward. If two electrons, instead of one, are held by the droplet, the effect is doubled.

Doctors Hull and Williams have measured the charge of the electron in a different way, by means of the Schrot effect, and have opened a field for research which promises to add to the knowledge regarding the electron and its properties. Previous attempts were made by German scientists to make the electron audible, and to measure the charge of the electron by this method. Only approximate values were obtained, however. By the procedure used by Drs. Hull and Williams it is possible to obtain values of high accuracy. The measurements thus far made by this method give a value for the charge of the electron within one half per cent of Dr. Millikan's value. The scientists made the measurements while working with radio frequencies and studying vacuum tubes.

Atoms have also been made audible within the past few weeks. It was recently announced that a device had been perfected in the research laboratory of the General Electric Company that reproduces in a radio loud speaker the rustle made by bringing a magnet close to a bar of iron and thus making groups of atoms stir themselves.

SCIENCE SERVICE

Germans Again Claim to Make Gold from Mercury. The transmutation of mercury into gold, which was recently reported to have been accomplished by Prof. A. Miethe of Berlin University and generally questioned by other chemists, is now announced to have been confirmed by his collaborator, Dr. H. Stammreich. He claims to have repeated Miethe's experiment, using mercury which careful analysis had shown to be "absolutely free from any trace of gold" but which at the end of the process was found to contain appreciable amounts of the precious metal.

Approximately one and one-half kilograms of mercury were used in a mercury arc lamp. The lamp was operated for 197 hours with from 160 to 175 volts at 12.6 amperes. The gold produced amounted to eighty-two millionths of one gram, or a little less than three ten-millionths of an ounce.

Obviously no commercial or economic results can be expected from this discovery, say the scientists, for the cost of producing gold by this method is hundreds of thousands of times higher than the value of the gold itself. But as an actual demonstration of a chemical feat held theoretically possible ever since the discovery of the electronic composition of the atom, the result is of great scientific importance.

The conversion of mercury into gold reported from Berlin is admitted by American and English scientists to be possible, but the sufficiency of the energy used and the reliability of the tests applied by the Germans for the detection of the gold have been questioned.

Dr. R. A. Millikan, winner of the Nobel prize for physics last year, in response to an inquiry by Science Service, declared that no experiments on the production of gold from mercury have been made or planned in the Norman Bridge Laboratory, Pasadena, California, of which he is director. He points out that "reliable results are very difficult to obtain because traces of gold are practically always found in mercury anyway."

Prof. W. D. Harkins, of the University of Chicago, well known for his work on atomic structure, declares that in the mercury vapor lamp, with which Prof. Miethe claims to have produced gold, the energy brought to bear upon the atoms of mercury is exceedingly small in comparison with the amounts of energy in all actual artificial disintegrations thus far accomplished.

"According to accepted theories it also seems probable," he says, "that such small amounts of energy would not be able to penetrate the outside of the atom to get at the nucleus at all. Prof. Haber found gold in Miethe's mercury and this is undoubtedly accurate but Haber disclaims all knowledge of how the mercury got in. Experts in this field will not trust any reports of atomic disintegration by large or small currents, unless voltages of millions of volts have been used, until they are supported by experimental work carried out with the most extreme precautions in such a way as to give definite evidence that the results claimed have been obtained. It is possible that Miethe has such evidence. I have not repeated his experiments.

"Mercury would be converted into gold if a hydrogen nucleus were lost from or an electron added to mercury's nucleus. I have bombarded argon nuclei by helium nuclei with an energy corresponding to five million volts without their disintegration. The voltage used in a mercury vapor lamp is small."

The products of Prof. Miethe's first experiment were analyzed in the laboratory of Dr. Fritz Haber, famous for his work on nitrogen fixation. Prof. Haber, when in this country recently, informed a Science Service representative that silver as well as gold was found in the samples submitted. This is taken to indicate that both silver and gold were present as original impurities of the mercury, since they are usually associated together in mercury ore.

Dr. Frederick Soddy, the English chemist at Oxford stated in a British scientific publication that even in advance of the German announcements, it appeared to him that not only was such a transmutation possible but that it was inevitable unless our present views of atomic structure are radically at fault. He believes that the chemical detection of the gold produced, not the transmutation, would probably be the more formidable experimental difficulty. SCIENCE SERVICE

Missing Chemical Element Located by One Faint Clew. Element 61, one of the five missing chemical building blocks of all matter, may soon be revealed to the world.

Prof. C. J. Lapp, of the University of Iowa, told the American Physical Society at Washington in December of his systematic search for this elusive element, which, though not heretofore detected by chemical or physical means, has had many of its properties predicted. Element 61 is known to be a rare earth, in the same class with cerium, whose oxides are used in the manufacture of gas mantles. There is a vacant space in the periodic table of chemical elements between number 60 neodymium, and 62 samarium, waiting to be filled.

One faint clew to missing element 61 has been found by Prof. Lapp. By examining some samples of rare earths carefully prepared by his colleague, B. S. Hopkins, he has discovered a single and very faint line in the spectrum produced by X-rays reflected onto a photographic plate from the rare earth sample. This line is not claimed by any other chemical element and corresponds very closely to wave-length to a line predicted on theoretical considerations as belonging to element 61. On this evidence, Prof. Lapp believes it likely that element 61 is present in his samples of rare earths in quantities of about 1 part in 2000 or less.

Even if later research results in the definite identification of element 61 and its chemical isolation, it is doubtful if it will be of any commercial value. Very few of the

rare earths are utilized in everyday life and they are usually so mixed up, one with the other, that they are only occasionally separated with any degree of purity. The rare earths include such unfamiliar elements as: cerium, praesodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, cassiopeium.

There are now only five missing chemical elements, including number 61. All the rest of the 92 elements, from the lightest, hydrogen, to the heaviest, uranium, have been discovered. Numbers 43, 75, 85 and 87 are among the missing.

Many of the chemical elements have been first discovered in the spectrum and then found and isolated by chemical means. Helium was discovered in the sun in 1868 by lines seen in the spectrum of sunlight and not until 1895 was it isolated by Sir William Ramsay. The latest conquest of physics and chemistry was the discovery of element 72, hafnium, by the Dutch physicist Coster and the Hungarian chemist Hevesy working in the laboratory of Prof. Niels Bohr in Copenhagen. Using first the X-ray spectroscope and then chemical methods, they discovered that hafnium frequently occurs in zirconium minerals and makes up about one two-hundred-thousandths of the earth's crust. It is more plentiful than the well known metal, tungsten. The periodic table of elements, devised by the Russian chemist, Mendeleeff in 1869, arranged the elements in logical order and allowed prediction of some of those then missing. Moseley, the young British physicist who was killed early in the World War, was able by applying X-ray spectroscopic methods to arrange the known chemical elements in an orderly series according to their atomic numbers. This classification is more enlightening than the Mendeleeff periodic table and has allowed more precise prediction of the properties of missing elements. SCIENCE SERVICE

The Race of the Rare Earths. Strongly resembling a Marathon race is a method recently reported by a Columbia professor for separating from each other certain chemical elements that seem to have an inordinate tendency to stick together no matter what the chemist may do to break the family ties.

These elements, sixteen in number, are known collectively as the rare earths. They are really not rare at all, compared to a number of other elements, but while the crude ores were rather easily and cheaply obtained, it required months and in some cases years to isolate the individual members in a pure condition. The consequence is that only in a few instances have scientists had the patience and the interest to carry out these fractionations which consist of from several hundred to as many as fifty thousand repetitions of the same operation. The result is that the rare earths are little known even to chemists, and since almost no pure material has been available for testing, they have found but slight commercial application.

The rare earths are like a family of brothers who have been brought up to be precisely similar in every thought and act. It is impossible to lure one away from the others by any ruse or temptation. Not that they are above temptation, however. The difficulty is that they all yield at once.

But complete identity of individuals is unknown either among the chemical elements or among human beings. The method devised by Prof. James Kendall and Dr. Beverly L. Clarke is based on the fact that if all the brothers are started at the same time on a long race, slight individual differences in speed will cause each one to pass the judges' stand at a different moment. If now they are prevented from running back together, a separation is effected.

The apparatus used is a long glass tube provided with electrodes for passing an electric current of fairly high voltage through the contents of the tube. A hot solution is made of salts of the rare earths and to it is added some agar-agar, a substance which causes the liquid to set to a stiff jelly on cooling. This jelly is placed near one end of the glass tube, while on one side is placed a jelly containing an element of a speed slower than any of the rare earths, and on the other side a jelly impregnated with a faster element. The jelly is used simply to prevent the mixing that would occur with liquid solutions. The current when turned on affects the rare earth brothers and the two jailers on either side just as it would affect human beings. It creates a desire in all concerned to move away from there with the highest speed at their command. The faster and slower elements serve to prevent the rare earth section from spreading out, and so the section as a whole moves along the tube and the individual rare earths begin to arrange themselves in a series representing their respective speeds or abilities to get away from the electric energy that is urging them on. Provision is made for running the same sample through the tube a large number of times and when a sufficient separation has been obtained, the jelly is removed and quickly sliced into thin sections from which the individual rare earths may be extracted in a pure form.

Up to a few years ago about the only use for the rare earths outside of that of museum curiosities was in the preparation of mantles for obtaining the maximum luminosity from illuminating gas. Thorium and cerium are the metals chiefly used for mantles. With the advent of radio, however, a new use has been found for some members of this family as a coating for the filaments of the vacuum tubes, to enable radio fans to use dry cells instead of storage batteries. It seems highly probably that further research will unearth new and varied fields of employment for these interesting elements, and the new method of separation stands ready to furnish the rare earths in a much purer form, and at a minute fraction of the time and expense formerly required.

Incidentally, the new method is capable of application to other problems than that of the separation of rare earths. Hopes are entertained by its authors that through it will be found a means of purifying certain ores of radium which now practically go to waste, and thus of increasing the supply and lowering the cost of this element that is of so much importance to medicine and pure science alike. SCIENCE SERVICE

European Chemist Finds Substitute for Platinum. Platinum laboratory vessels, indispensable in certain chemical operations, have become very expensive, due partly to the increased use of platinum jewelry and partly to the virtual cutting off of the Russian supply, formerly the principal source of the metal. Dr. A. Gawalowski, an Austrian chemist, reports, the successful use of vessels made of an alloy of silver and aluminum, thinly coated with platinum by an interesting process. The alloy was dusted over with "platinum black" a microscopically fine dust of platinum, and then hammered or rolled under heavy pressure. This peculiar method of plating gave the allot sufficient protection against the strong acids and alkalies of the chemical laboratory. SCIENCE SERVICE

Air is Blue. Air is a blue-colored gas, according to recent investigations of Dr. C. V. Raman, noted Hindu physicist of the University of Calcutta. Dr. Raman is taking advantage of the brilliant sunlight of Pasadena for a year of research at the California Institute of Technology.

Classic school-books have always said that air is a colorless gas. To this Dr. Raman counters—"Look up at the sky." The advice is simple, although the obvious deduction from it has not been accepted in the past. In fact the blue color of the heavens has been attributed in recent publications to intensely cold nitrogen crystals in high altitudes. This ingenious theory is discredited by Dr. Raman as fanciful and at best entirely unproven and unnecessary.

Air-layers of ordinary thickness, such as one views within short distances, do not reflect enough of the blue light to give a blue reaction on the retina of the eye. Dust and moisture confuse the results in most cases, anyway. For exact observation, two plans logically follow. One is to examine a layer of clean dry air many miles thick, *i. e.*, to behold the sky. When the test is made at high altitudes, the atmosphere overhead becomes too thin to exhibit the full blue color of the air, and the sky becomes blue-black, a color which merely indicates lack of reflection. Such an observation does not substantiate the frozen nitrogen crystal theory.

The second plan of observation, which is the basis of Dr. Raman's experiments at Calcutta, is to admit a highly concentrated beam of tropical sunlight into purified air in an intensely dark room. The experimenter has dubbed his dark chamber the "black hole of Calcutta." It required a half-hour for the human eye to become thoroughly accustomed to the Stygian darkness of the "hole," before the blue color of the air can be observed.

The apparent absence of color in ordinary air is explained as easily as the case where one drop of blue ink is stirred into a barrel of water. The air is diluted in space instead of water, and weighs less than a fifth of an ounce per gallon even at levels of high density.

The experiments of the Hindu physicist are conducted for the purpose of determining the form and structure of gaseous molecules. Success in the investigation will mean that a chemist may check his ideas of structure of drugs, dyes, etc., by the type of light waves which are reflected from the molecules. SCIENCE SERVICE

Claims Resins were Origin of Diamonds. Similarity between the X-Ray pictures of the lattice structure of diamond crystals and of decaterpene, a resinous substance, is the basis for the claim advanced by Herr Decker, a Jena chemist, that diamonds originated from this material under enormous pressure and possibly heat, during long periods of time, according to the Berlin correspondent of Industrial and Engineering Chemistry.

Diamonds have long been known to be pure carbon in crystalline form, but what the original carbonaceous material was out of which they developed has been a subject

of dispute. Resins contain hydrogen as well as carbon, and the theory of the German scientist assumes that under the conditions of diamond formation the hydrogen was literally slowly squeezed out of the raw material until at last nothing but pure crystalline carbon was left. SCIENCE SERVICE

High School Chemistry and the Periodic System. P. M. GLASOE. *School Science and Mathematics*, **24**, 700 (1924).—Science is systematic knowledge, hence chemistry should be grouped around the Periodic System. Study of the table should be introduced very early, by asking the class to arrange the first twenty elements in the order of atomic weights, then characterizing each as metal or non-metal. Periodicity appears at once. Next show that metals are positive and form basic compounds while non-metals are negative and acid-forming. Then the combination of metal with non-metal leads up to valence, which is related to the groups of the Table in several interesting and helpful diagrams. Structural formulas and variable valence lose their terrors for the beginner. The Mendelejeff grouping of the long series is confusing so an extended arrangement is suggested. Use of this table has made first year chemistry a unified and organized whole instead of a jumble of disconnected facts and figures. B. S. HOPKINS

The Alchemist. P. D. FOOTE. *The Sci. Monthly*, **19**, 239–262 (1924).—There were two types of alchemists: (1) *the knavish*, who duped the people and made money at their expense; and (2) *alchemists proper*, who sincerely believed that gold could be made from base metals. Chemistry owes its origin to the work of these honest men. Apparently they were overworked individuals, who were sooty and black like smiths and colliers. Alchemy as practiced during the Middle Ages was the logical outgrowth of the philosophical thinking of the ancient Greeks, who believed in the doctrine of four elements.—Earth, Fire, Air, and Water. The processes of the alchemists were subdivided into twelve groups: calcination, dissolution, separation, sublimation, etc. They employed a mystical language to guard their secrets. The writer next discusses *modern alchemy*. The postulate is laid down that the nucleus of an atom consists of three kinds of building blocks: (1) *hydrogen nuclei or protons* (2) *helium nuclei* or *alpha-particles* (3) *electrons*. Rutherford has bombarded atoms of nitrogen, aluminium, and other elements with alpha-particles and obtained hydrogen nuclei. Transmutation is therefore an accomplished fact. If a hydrogen nucleus could be ejected from a mercury atom of atomic weight 198, gold should result. When the scientist is able to utilize an electric field of 10 million volts, there is small doubt that every element may be produced by transmutation. WILLIAM FOSTER

High School Science Teachers. A Study of Their Training in Relation to the Subjects They are Teaching. P. W. HUTSON. *Educ. Adm. and Super.*, **7**, 423–438 (1923).—Report of a questionnaire investigation of the training and the teaching programs of the high school teachers of the State of Minnesota. In schools of more than thirty teachers, 39.5 per cent of science teachers taught only one subject. Some taught as many as five. In school of less than 10 teachers all science teachers taught more than one subject. 30.8 per cent of the chemistry teachers in the largest school taught chemistry as a single subject; but there were none in schools of less than 30 teachers who taught it as a single subject. In 72.1 per cent of the cases the science teachers in larger schools either taught their subject singly or in combination with some division of natural science. In schools of less than 30 teachers combinations are most likely to include some subjects outside the field of natural science. In the largest schools (30 teachers or more) 50 per cent of the teachers of chemistry had taken less than 24 semester hours of preparation in this subject in higher institutions. More than 75 per cent had taken less than 30 semester hours. Teachers of chemistry were generally better prepared than teachers of physics. About 20 per cent of all teachers reporting (252 cases) had taken as much as 12 semester hours in more than one division of natural science. S. R. POWERS

Photosynthesis. E. C. C. BALY. *Ind. Eng. Chem.*, **16**, 1016–1018 (1924).—The article is a review of recent work on the effect of ultra-violet light on (I) aqueous solutions of carbonic acid and (2) fairly concentrated solutions of formaldehyde. The exposure of aqueous solutions of carbonic acid to ultra-violet light results in the formation of formaldehyde to the extent of about 2–8 parts per million. Substances capable of reducing Benedict's solution were also produced. The theory is suggested that the reducing substances are the primary products and that the formaldehyde is formed as a result of their decomposition. This is confirmed by the fact that light does not form reducing sugars on formaldehyde solutions of very low concentration. Optimum conditions are: a wave length of about 220 $\mu\mu$, an exposure of not more than eight hours, quartz reaction vessels at a distance of about 8 in. from quartz mercury lamps oper-

ated at a current of 250 volts. In the presence of potassium or calcium nitrite the reaction results in the formation of formhydroxamic acid instead of formaldehyde. Solutions of 40 per cent formaldehyde exposed to mercury lamps will, after eight days, produce a sugar solution of about 8 per cent, reducing power. The temperature should be about 37° and the hydrogen-ion concentration equal to that of calcium bicarbonate solution. After purification by a method described in the article, a viscous, yellow, transparent fluid is produced in which hexoses have been proved to be present. The complete absence of pentoses and trioses has been proved. Q. C. DRAKE

Supervised Study in Natural Science. CHARLES J. PIEPER. *Sch. Rev.*, **32**, 122–133 (Feb., 1924).—Selects a unit from the course in chemistry (oxidation) for illustration of a technic for supervised study. The principal activities of the student through which he develops proper habits of study in the realm of science are: (1) listening to the spoken words, (2) reading, (3) interpreting observed phenomena, (4) interpreting diagrams and pictures, (5) organizing knowledge, and (6) oral and written expression. All of these activities are forms of individual study and require carefully directed supervision. The classroom procedure involves five steps: (1) a pretest to determine the student's previous knowledge of the subject of study. (2) A preview in which the instructor briefly outlines the units, raises questions for study and gives directions concerning note taking, observation of demonstrations, etc. When the members of the class feel they understand the preview they are required to write a report of it in their best English. (3) Assimilation. The students survey the questions in their mind which are left unanswered from the pretest and preview and formulate the best procedure for their study. This involved the use of laboratory exercises, teacher demonstrations, and reading and in each of these there is opportunity for direction and improvement of the students' method of work. (4) Organization. The student lays aside all books and prepares a topical or statement outline of the unit. (5) Recitation. This includes discussion and oral reports. Appropriate student activities and methods of testing are described to accompany each of these five steps. Supervised study involves the diagnosis and correction of study-attitudes and study-habits as they are disclosed in the activities associated with the study which leads to understanding of science facts and phenomena. S. R. POWERS

New Chemistry Building at the University of Saskatchewan. *Can. Chem. and Met.*, **8**, 245 (1924).—Officially opened Aug. 22, 1924, on occasion of visit of the Brit. Assn. Floor space 57,000 ft.; structural steel; hollow tile-reinforced concrete floors; positive ventilation system of washed air at const. temp.; two separate exhaust systems, one for hoods and desks; plumbing wholly exposed. Description of labs. and offices, etc. R. A. BAKER

On Buying Laboratory Supplies. (Editorial.) *Can. Chem. and Met.*, **8**, 56 (1924).—"Except in certain standard instances the buyer has no chance to deal with the manufacturer direct. For example, it is quite possible to receive German goods from either the U. S., Canada or Great Britain." The market is ruled by adaptability, quality and price so there is "poor opportunity to be particularly patriotic." R. A. BAKER

Opportunities for Science Teachers in New York High Schools. R. A. BENEDICT. *Science*, **60**, 524 (1924).—B. reports a shortage of well-qualified teachers—particularly of men for boys schools. There are at present 35 high schools, ranging from 1 to 8 thousand, and requiring between 4 and 5 hundred specially selected science teachers to offer the courses now given. A large expansion seems imminent. Salary range is $1900 to $3700 (or to $4200 if chairman of department), credit being given for recognized outside teaching and graduate work. Opportunities for graduate work in N. Y. are emphasized. Details may be obtained by addressing Board of Examiners, 500 Park Ave., N. Y. City. R. A. BAKER

The Astronomy of the Atom. ROBERT A. MILLIKAN. *School Science and Mathematics*, **24**, 810 (1924).—The spectroscope bears a relation to atomic mechanics analogous to the telescope's relation to celestial mechanics. The telescope checked the quantitative application of Newton's laws to astronomy. The spectroscope makes possible a similar testing of the orbital theory of electronic motion. Work reported in this paper was made possible by the use of a high vacuum "hot spark" spectrometry. Its service extended the spectrum of chemical elements three or four octaves further into the ultra-violet than had ever been photographed before. Atoms of boron were studied. The "hot spark" vacuum both ionized and completely stripped them of their valence electrons. Spectro-photographs were taken of these valence-stripped atoms. On these photographs lines were located which represented frequencies set up for shifting of electrons, both from the fifth to the fourth and from the third to the second electron orbits. These frequencies were compared with those calculated

by use of Bohr's theory. In the first case the agreement was to one part in 5000 and in the second to one part in 800. A double line was found in the second of the two cases cited. Sommerfield's theory, based upon Einstein's theory of relativity and upon the assumption that two electron orbits, one circular, the other eleptical, are involved, explained this double line. The measured separation of the two lines agreed very well with the value determined by calculations based upon Sommerfield's theory. Correspondingly good agreements were found for doublets in lithium, beryllium, carbon and nitrogen. Thus these studies of spectrum doublets, of valence stripped atoms of a number of chemical elements, lend weighty support to the conception that there is orbital motion of valence electrons about the nucleus of the atom.

B. CLIFFORD HENDRICKS

Science Teaching in a Democracy. E. E. SLOSSON. *Chicago Schools Journal*, October, 1924.—By analysis and classification the scientist has reduced the raw materials of the earth to useful form. In this process he finds that the more coldly impersonal he becomes, the more does Nature yield her secrets. By reason of his lack of human quality and the fact that other professions market his wares, the research scientist has received little credit from the public for his fundamental work. Much of the appreciation of men of science has been posthumous. "There is no reason to think that Pasteur or Roger Bacon takes any pleasure in our celebration of their birthdays. But what needs to be brought out is how a single scientific discovery may transform everyday life, industrial conditions, international affairs and the prevailing mode of thinking. The world needs to understand what scientific training does to the mind of man." Science will not receive due appreciation for its gifts to humanity until the human element so sedulously eliminated by the researcher is returned. Dissection and desiccation have no place in elementary science teaching and possibly not in the college. They are the handmaidens of those who have renounced the allurements of human kind to devote themselves to the service of Mistress Science. Most erroneous ideas are conceived in the minds of pupils by the over-classification of science. Teachers respect the boundary lines too much. The younger the pupil the more natural and integral should the material be. Science must be studied in habitat. "It is difficult to get from the consideration of hash an integral idea of what creature supplied the meat." "If science teachers merely teach their students to use the appliances of science and fail to train them in the scientific way of thinking they may find the intellectual aims of science defeated by the machinery of science. The printing press contributes to the spread of superstition and obscurantism as well as the spread of science. By means of the radio Voliva's argument for a flat earth is broadcasted from Zion all around the world. Science teachers in the secondary schools occupy a strategic position for influencing the thought of the nation. They give all the instruction in science that most of the people ever get and they have first chance at those who go on to the university. The main object of education in a democracy is not to teach the students how to vote right, but to train them how to think right. H. R. SMITH

Public Education in Poland. M. MAZUROWSKA. *N. Y. State Educ.*, **12**, 32 (1924).—The whole educational system is undergoing reorganization. Administration of all grades and branches, from kindergarten through the universities, including private schools, is centralized in the National Department at Warsaw. Laboratory work in elementary science is begun in the second grade and is emphasized throughout. National interest in education is discussed, as well as subsidies received by teachers in the form of reduced railroad, hotel and theatre rates and scholarships. R. A. BAKER

Fifty Years of Chemistry in America. WM. H. NICHOLS. *Science*, **60**, 1553 (1924).—Address given at celebration of Professor Edward Hart's fifty years of service at Lafayette College first gives a tribute to Dr. Hart and his work. The main address is a resumé of the advances of technical chemistry in fifty years using the story of each of these as outstanding examples—sulfuric acid, Solvay soda, petroleum refining, by-product coke ovens, electrolytic refining of copper, dye-stuffs, fixation of nitrogen. He closes with a prophecy of the future of the chemist working with the physician probably annihilating most of the enemies of the body. J. N. SWAN

The Making of a Compleat Chemyst. HENRY E. ARMSTRONG. *J. Soc. Chem. Ind.*, **43**, 1077–88; 1100–3 (1924).—This address combines the ability of a Kipling in the use of words and the brilliancy of a Huxley in emphasizing a modern need for a culture based on Natural Science as contrasted with the purely literary culture of previous periods. The speaker emphasizes uniquely these points. There is good food for the development of the "bloomin' soul" in more familiarity with the modern methods of arriving at truth and a better appreciation of the beautiful wonders in nature. The paralleling in other departments of life, the results of training in chemistry for

detailed observations and their correlation into a sound conclusion. The development of good speech can better be accomplished "through the translation of every-day action into thought—through the description of things done than through classics—in translating." He notes Isaac Walton's "Compleat Angler" has a literary charm as well as technical lore, therefore, why not the "Compleat 'Chemyst.'" He appeals for real experimental work by students, which "is properly done only when it is properly described," rather than in mere verification work. He feels that the "Compleat Chemyst" is not confined to the narrow groove of a specialist but has a broad outlook chemically and remembers that man has a "bloomin' soul" to develop. LOUIS W. MATTERN

College Placement Examinations. C. E. SEASHORE. *School and Society*, **20**, 515 (1924).—Dean Seashore is an ardent advocate of sectioning college classes on the basis of their ability. His able report in the Bulletin of the American Association of University Professors, 9, 6 (1923), should be read to get an idea of the full value of these examinations. To quote him, "Every instructor who tries a placement examination for the first time will be astonished at the enormous difference in ability or equipment for the work of the year, because the differences as we generally experience them in ordinary instruction are covered by the individuality-crushing process of the present system of instruction. He will soon realize that it is not enough to know this difference, but that something must be done. Many of the remedies in sight are now pretty well known, such as sectioning on the basis of ability, options in the election of courses, individual instruction, socialized instruction, giving a student credit for a subject he already knows, or sending him back to a preliminary course. There is no simple mechanical solution for this central problem of educational procedure." It calls for getting teachers out of their traditional ruts and invokes the use of common sense in meeting this new situation which is laid bare by the placement examination." The examination is to cover the first two hours of the course. The first hour is to test Chemical aptitude and consists of four parts:

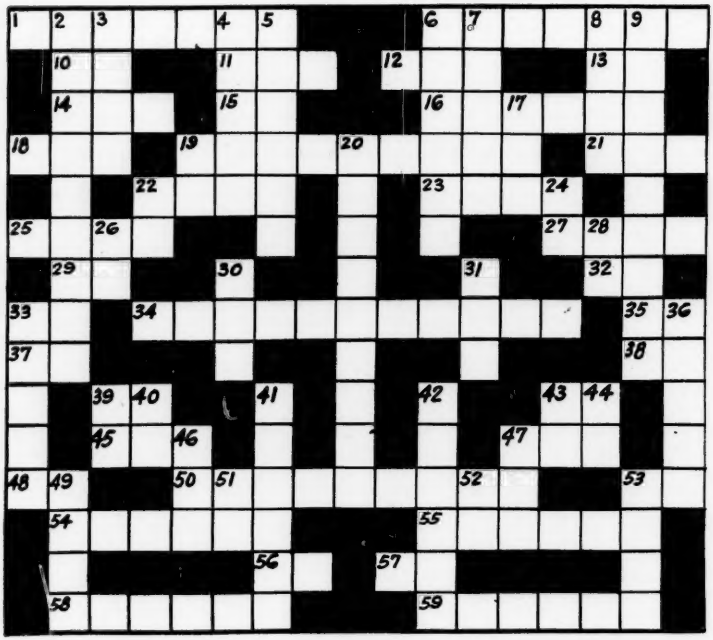
1. Simple arithmetic of Chemistry
2. Ability to secure precise data from chemical paragraphs
3. Chemical reading comprehension
4. Interest in Chemistry (as measured by accuracy of common observation).

The second hour is devoted to Chemical training and can be given only to those who have had a secondary school course in chemistry. The examinations are published by the Extension Division of the University of Iowa. They are gotten out in such a way that they can be quickly and easily graded. The teacher who gives this examination, especially the first part on Chemical Aptitude, before administering a course in Chemistry will find the hour well spent. G. H. WHITEFORD

Trend of Developments in the Nitrogen Problem. J. M. BRAHAM. *Ind. Eng. Chem.*, **16**, 1277 (1924).—Nitrogen fixation processes, which have been the subject of intensive investigation in the United States and many foreign countries, are now producing 500,000 Metric Tons of nitrogen annually, nearly half the world's output. About 75 per cent is produced in Germany, and very little in the United States. The arc process, put into operation in 1905 in Norway, produces about 36,000 M. T. annually. The enormous power development needed, about 68,000 Kw.hr. per ton, is the great handicap in this process. In 1913 nine countries were operating cyanamide plants. Five years later, 36 plants were producing 325,000 M. T. annually. Following the War some plants were scrapped, and the largest of them all, U. S. Nitrate Plant No. 2, now lies idle. Since calcium cyanamide is not entirely satisfactory as a fertilizer and the costs of converting the cyanamide into other nitrogen compounds is high, this process is being superseded by the synthetic ammonia process. The first commercial installation of the synthetic ammonia process began in 1913. Two plants with a total capacity of 300,000 M. T. annually were built in Germany during the War, an amount nearly equal to the nitrogen production in Chile. There are now 14 synthetic ammonia plants in operation in the various countries, three of them in the United States. The main problem is the production of hydrogen. The Haber-Bosch process prepares hydrogen from water gas; the Claude process by the fractionation of coke oven gas; and the Casale process by the electrolysis of water. With improvements in processes and catalysts it seems probable that ammonia can be produced here in a large installation at 5 or 6 cents per pound. The direct products of these three processes, nitric acid, calcium cyanamide, and ammonia are converted into the following compounds: calcium nitrate, sodium nitrate, ammonium chloride, ammonium sulfate, ammonium phosphate, ammonium nitrate, and urea. There is every reason to believe that within the next ten years this country will be supplying a large part of its nitrogen compound needs through the fixation of atmospheric nitrogen. CHAS. E. DULL

Measurements of the Results of the Teaching of Chemistry. HENRY L. GERRY. *School Science and Mathematics*, **24**, 793 (1924).—The author discusses methods of grading accomplishment in present day chemistry. The uncertain results of the oral quiz are noted and many factors influencing the teacher's judgment are mentioned. The written test is said to be subject to much variation and the factors are enumerated. The "group" judgment of marking is explained. The author believes that the College Board and Regents Questions have certain disadvantages and it is stated that this type of examination has little influence in determining the judgment of the teacher. Attention is called to a more modern supplementary method of testing that gives more accurate results. The history of the "standard" test is reviewed. The type of questions and form of expression are formulated by a group of specialists who have given considerable thought to the general subject of examinations. The questions require reason rather than mere memory, and are designed to stimulate interest. The mechanics of the test are simpler, time is saved for the teacher, and nearly quantitative results in the estimation of achievement are obtained. The subject will be continued in a subsequent paper. This discussion should be of interest to all teachers.

R. N. MAXSON



HORIZONTAL

1. An Italian province producing sulphur, salt, iron, and marble.
6. Varying form of an element having different density and atomic weight.
10. Erbium (symbol).
11. Trinitrotoluene (a high explosive).
12. Potassium hydroxide.
13. Chemical prefix meaning "two."
14. A speck, or spot.
15. Simplest formula for hydrogen peroxide.
16. A Great English chemical scientist.
18. A great help in finding new elements.
19. A compound found in bases.
21. Royal College of Physicians (abbr.).
22. To reduce copper oxide by a green log.
23. A gaseous element occurring in very small quantities.
25. A state abounding in salt.
27. A substance with an absence of coloring matter.
29. A prefix meaning "equal."
32. That is.
33. Uranium oxide.
34. A kind of burning when caused by oxidation without help.
35. Chlorine.
37. Manganese.
38. Knight of St. Andrew (abbr.).
39. Lead.
43. Calcium.
45. Prefix signifying presence of three atoms in a compound.
47. Iodine monochloride.
48. Royal Dean.
50. One use of chlorine, bromine, sulphurous acid, carbolic acid, etc.
53. Arsenic.
54. A compound capable of turning litmus blue.
55. An acid obtained by distillation of wood or oxidation of alcohol.
56. The hydroxyl group.
57. Scandium (symbol).
58. A clay-like white or reddish hydrous aluminum silicate.
59. A rare inert gas, lighter than air.

VERTICAL

2. Deoxidizing; depriving of non-metallic elements.
3. The most numerous of the metallic elements.
4. An organic radical of the paraffin series. Used with alcohol.
5. The current entrances, as in electrolysis.
6. A bluish black haloid element.
7. A state of illumination, or presence of more or less coloring matter.
8. The disagreeable part of hydrogen sulphide.
9. An alloy of copper, zinc, and tin to imitate gold.
17. The fifth sign of the Zodiac.
19. Simplest formula for hydrogen peroxide.
20. The act of uniting with oxygen.
22. Phosphorous hydride (without sub-numbers).
24. Sodium.
26. Arsenic.
28. Lithium.
30. A bar of metal.
31. An electrified particle.
33. A chestnut-brown hydrated ferric oxide.
36. Pigments formed by combining coloring matter with metallic oxide.
39. Platinum.
40. Bromine.
41. Act of melting or blending.
42. To cause to become colorless or white.
43. Cubic centimeters.
44. Aluminum.
46. One of the three supersensitive currents in humans.
47. Suffix denoting salt of acid in "–ous."
49. Having little coloring matter, a shade.
51. Prefix signifying "not."
52. Cubic centimeters.
53. A mixture consisting of one part alcohol, two parts chloroform, and three ether. (abbr.)

Answers to be placed in February issue of THIS JOURNAL.

Local Activities and Opportunities

Cornell University. Edward P. Phelps has taken a position as a research assistant at Cornell University. For the past three years he has been an instructor at Tufts College.

Ohio State University. T. H. Swan has changed his research position from Ohio State University to Mellon Institute of Industrial Research at the University of Pittsburgh where he is investigating a problem on metal finishing.

University of New Hampshire. Henry R. Kraybill, Professor of Agricultural Chemistry and chemist in the Agricultural Experiment Station, University of New Hampshire, has resigned to accept a position as bio-chemist in the Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.

Joseph T. Sullivan, formerly Graduate Assistant in the Department of Agricultural Chemistry, University of New Hampshire, has been appointed Assistant Bio-chemist in the Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.

West Virginia University. West Virginia Academy of Science was organized November 28, 1924, with the following sections functioning: Biology, Botany and Zoölogy; Chemistry and Pharmacy; Engineering; Geology and Mining; Mathematics, Physics and Philosophy; and Social Sciences.

Oberlin College. Dr. Ralph N. Mason, of the staff of the University of Kentucky, is spending a semester's leave at Oberlin College, working on a colloid problem with Dr. Harry N. Holmes.

Nebraska Chemistry Teachers. Nebraska's teachers of chemistry are working with the State Teachers' Association. Its all-state meeting occurred Dec. 29, 30, in Omaha. The Physical Science section gave one full afternoon's program to chemistry. The subjects were: "The High School Chemistry Course as Suggested by the A. C. S.;" "The Value of the A. C. S. Prize Essay Contest," and "The Basis of Correlation of High School and College Chemistry."

Doctor Paul Sears, president of Nebraska's Academy of Science is lending encouragement to the efforts of the A. C. S. sections in Nebraska in putting on a program for the teachers of chemistry at the 1925 spring meeting. Both the Academy and the A. C. S. sections feel the need of closer affiliation with the state's high school and college teachers of chemistry.

Educating the Public. The "Chem Club," an organization of students in chemistry, at the University of Illinois presented a "Chem Show" to which the public was invited. In general the chemical stunts were directed by members of the chemistry department with the assistance of students. The show drew a large crowd, 1200 visitors. Of the two hundred or more exhibits, no one exhibit attracted the most of the crowd—there were too many interesting things. The glass blower demonstrated the making of intricate apparatus from glass. There was a chlorine room for treating colds, fitted up with reading lamps and easy chairs. During the show the industrial division made casein from 2000 lbs. of milk for the use of the physiological department. There was a man made up of bottles and rubber tubing showing what happens to food taken into the body. There was a clinic for testing blood. The science of fudge-making was demonstrated and the fudge was sold—much faster than it could be made. The strength of vinegar was tested for any who brought samples to be analyzed. Then there were displays of the research being carried on about the building and of the type of work taught. There were also shown some of the more spectacular chemical reactions. These cover but a few of at least two hundred exhibits. Small boxes of colored fire and test-tube vases were given out upon the fourth floor as an inducement for the weary to keep on climbing.

The show was very successful and demonstrated the interest of the people in general in chemistry.

Eastern High School, Rochester, N. Y. "Mark A. Kreag, of No. 42 Alliance Avenue, formerly a pupil at East High School and now at the University of Rochester, was awarded first prize in the prize essay contest of the Rochester Section of the American Chemical Society. The prize, consisting of a $10 gold piece and a gold medal, was presented the winner by Dr. Leo H. Baekland, president of the American Chemical Society, previous to his talk

here December 2, before the Rochester Section. Mr. Kreag's essay on "The Relation of Chemistry to the Enrichment of Life," also won one of the state prizes in the American Chemical Society contest.

"In presenting the award, Dr. Baekland recalled that in his native city of Ghent, when he was about the age of the recipient, he also won a similar prize and strangely enough it was fifty francs, ($10), and a gold medal. He said the winning of that prize gave him greater incentive to study chemistry, and he hoped that this prize would have a similar effect on the present winner. At the same time, Dr. Baekland presented the East High School, through Mr. Kreag, a shield on which was engraved, "American Chemical Society Prize Essay Contest," the name of the winning pupil and the school which he attended. This will remain the property of the East High School to hold until won by a representative of another school.

"Honorable mention in the contest was given to Miss Rosemary Edelman, formerly of Nazareth Academy, for her essay on "The Relation of Chemistry to the Home." At a date yet to be announced, the essays will be read before the Rochester section. The Prize Essay Award Committee consisted of Harry A. Carpenter, head of the department of chemistry at the West High School, and chairman; Dr. V. J. Chambers, director of the department of chemistry at the University of Rochester; and Florus R. Baxter, chief chemist of the Vacuum Oil Company."

Iowa Chemistry Teachers. The Chemistry-Physics Section of the Iowa Association of Science Teachers met at West High School, Des Moines, Iowa, on November 6 with Professor Bartow, head of the Chemistry Department of the State University of Iowa in the chair. Following the Physics part of the program, Secretary Alexander Williams, spoke of the Prize Essay Contest and suggested coöperation with the American Chemical Society in its educational program. In accordance with his suggestion, a coöperating committee was appointed, consist- of F. E. Goodell of West High School, Des Moines, as chairman, Professor F. E. Brown, of Iowa State College, and Frances Church of East High School, Des Moines.

Professor P. A. Bond, chairman of the committee appointed to investigate the teaching of chemistry in Iowa, reported on the work of the committee of Chemical Education of the A. C. S. This report pointed out the topics in the order of their importance in both the high school and college outlines. The committee also made the following recommendations as minimum drill topics for high school chemistry:

1. Correct writing of symbols, formulae, and balancing of equations.
2. Problems emphasizing weight relationships.
3. Recognition of acids, bases and salts and a clear conception of these interrelations and reactions.
4. Some knowledge of ionization as a phenomenon.
5. Knowledge of gas laws.
6. General knowledge of chemical phenomenology.

An active campaign is planned to reach every teacher of chemistry in the state for the purpose of promoting chemical education in Iowa.

University of Illinois. Dr. Margaret B. MacDonald, Associate and Research Professor of Biochemistry, at the School of Hygiene, Johns Hopkins University, is visiting this university for the year. Dr. MacDonald is doing research work on the biochemistry of yeast in the Bacteriology Department. F. G. Straub, graduate of this university has been appointed by the Utilities Research Committee to investigate the Brittling Action in Boiler Water. The Research will be conducted under the direction of Professor S. W. Parr.

Illinois Teachers Organize. Following the luncheon of the physical science section of the state high school conference held at the University of Illinois, on November the twenty-first, Professor B. S. Hopkins presented the outline of a plan for organizing an Illinois Chemistry Teachers' Association. The project met with the unanimous approval of the one hundred chemistry teachers in attendance at the conference a number of whom were representatives of Illinois colleges.

The presence of the large number of college teachers at the high school conference is accounted for by the attraction of an especially strong program which included an address by Prof. W. A. Noyes, on Chemical Education in Europe and two addresses by Dr. E. E. Slosson, Director of Science Service on Future Sources of Energy and The Mission of Science. Thus the new organization is fortunate in that it received at its inception the double impetus from high school and college chemistry faculties. After due discussion a committee on organization was appointed consisting of R. H. Davis, of Lane Technical High School, Chicago, Rosalie M. Parr, of the University of Illinois, and E. E. Rademacher, of the Township High School, of Nokomis.

University of Nebraska. Beginning each autumn semester, the University of Nebraska Department of Chemistry, grants some eight or ten teaching scholarships, paying $350 per year and has a few teaching fellowships, available to those having a Master's Degree, which pay $600 to $750 per year. Students interested in the chemistry of sugars, synthesis of organic arsenicals, oxidation potentials, flour and nutrition, solubility values of petroleum will find problems in these fields under investigation in Nebraska's Chemical Laboratory.

Chicago Association of Chemistry Teachers. The chemistry teachers of Chicago have formulated a comprehensive plan of Chemical Education. Three projects being studied are:

1. A statement of aims or objectives, evaluated and ranked as to importance.
2. How these objectives can be accomplished.
3. Survey and test to determine the extent of accomplishment.

The list of fundamentals will appear in No. 2 not as an end in itself but as a means to the bigger end of proper education.

University of Kentucky. Bids have been asked for the construction of the new chemical laboratory at the University of Kentucky. The building will be named in honor of the late Dr. Joseph Kastle, a graduate of the institution. Dr. Kastle was Professor of Chemistry for many years and later the director of the Kentucky Experiment Station.

Dr. R. N. Maxson will resume his duties as Professor of Inorganic Chemistry at the University at the beginning of the second semester. Dr. Maxson has been on leave of absence, and has been located at The Severance Chemical Laboratory, Oberlin College, doing research work on colloids.

The Kentucky Association of Chemistry Teachers. Organization of the chemistry teachers of Kentucky will be effected at a meeting to be held in Louisville in connection with the spring meeting of the Kentucky Educational Association.

Wisconsin Chemistry Teacher's Association. Since the organization of the Wisconsin Chemistry Teachers as given in the December issue of THIS JOURNAL, plans have been made to organize subsidiary groups in three other sections of the state, in connection with as many local annual meetings of State Teachers. Also plans have already been laid for the coming annual fall meeting of the section, at which time a very instructive and interesting program will include visits to some of the many modern chemical industrial plants in Milwaukee, in coöperation with members of the Local Section of the A. C. S.

University of Colorado. Among the new buildings to be erected at the University of Colorado at Boulder is to be a thoroughly modern chemical laboratory to cost about $300,000.

New Mexico. The New Mexico Educational Association met in Albuquerque, November 6, 7, and 8. The New Mexico Association of Science also met in the same city at the same time. Invitations to attend the meetings of the Science Association were sent to every teacher in New Mexico, and a large number of teachers were in attendance at all the meetings. The largest number of chemistry teachers ever assembled in New Mexico (approximately eight men), gathered together at an informal dinner during the meetings of these two Associations.

New Mexico has made very great progress in recent years along educational lines The state was devoid of a public school system until nearly the close of the last century. It required nearly twenty years for grammar schools to get a good foothold; the establishment of sound grammar schools has been followed by the establishment of high schools, and each year sees the study of Science gaining headway in the curriculum of these schools. While nearly all of the high schools of New Mexico offer a course in Physics only a small portion of them offer work in Chemistry. Perhaps this is not strange in a state completely devoid of chemical industries; as large as all New England, New York, and Pennsylvania; yet having a population smaller in number than a good-sized eastern city. The State University and the State Agricultural College are leaders in the movement to take well taught chemistry into the high schools of New Mexico.

Washington's Association of Chemistry Teachers. The Washington, D. C. Chemistry Teachers Association was organized at a meeting at the Cosmos Club, Washington, D. C., with an initial membership of more than thirty. The membership includes both university and high school teachers of chemistry. After listening to talks by Neil E. Gordon, Charles B. Munroe, Louis W. Mattern, and R. S. McBride, President of the Washington Section of the American Chemical Society, a constitution was adopted and the follow-

ing officers elected: President, George L. Coyle, professor of chemistry, Georgetown University; Vice-President, H. C. McNeil, professor of chemistry, George Washington University; Secretary, Miss Elizabeth Gatch, Central High School; Treasurer, H. A. Lepper, Bureau of Chemistry. The executive committee chosen consists of the officers of the association and Hardee Chambliss, professor of chemistry, Catholic University and E. A. Hill, George Washington University. Louis W. Mattern, McKinley Technical High School who was nominated as contributing editor to the Journal of Chemical Education.

Another meeting of the association will be held February, at the McKinley Technical High School. C. A. Brown, chief of the Bureau of Chemistry and other well known Washington chemists will read papers particularly adapted to the teaching of chemistry.

Radio Talks. The radio talks on chemistry, given by the Washington Section of the American Chemical Society in coöperation with the National Research Council, have proved extremely popular. Many requests for copies of talks on such topics as "Chemistry and Medicine," by Miss Marie O'Dea, instructor of physiological chemistry at George Washington; "Artificial Silk," by W. H. Smith, Bureau of Standards, and "Good Health and Good Nature," by M. X. Sullivan, bio-chemist of the Hygenic Laboratory, have been received. Many of them can be used in the classroom.

A new series of radio talks on chemistry is now in preparation by the George Washington Chemistry Society, composed of students in chemistry at that University, in coöperation with the American Chemical Society.

University of Maryland. A grant of money for the coming year has been given by the Hygienic laboratory of the U. S. Public Health Service, through Dr. M. Kharasch, to the University of Maryland, to carry on in coöperation work on the chemotherapy of tuberculosis. Mr. H. Isabel, at present employed at the Beltsville Experiment Station, is the recipient of the fellowship.

The pharmological work will be carried out at the Hygienic Laboratory under the direction of Dr. Carl Voegtlin.

New England Association of Chemistry Teachers. The eighth meeting of the Western Division, N. E. A. C. T. was held December 6, at New London, under the direction of Mr. Elbert Weaver, Chapman Technical High School of that city.

The morning program consisted of a thorough inspection of the Submarine Base, transportation to and from the Base being by means of a U. S. tug. At the Base one of the new types of submarines was visited and its intricacies were explained. The Training School was also inspected. Lunch was served at the Technical High School.

The afternoon program consisted of the election of Divisional officers and committees. Eighteen new members were elected. Committee reports were made. Mr. Weaver explained the working of a class model dissectable engine. Prof. Dimrick of the U. S. Guard Academy talked interestingly and clearly on "Relativity." Prof. Jackson, R. I. State College, explained the State Chemistry Contest. Mr. E. A. Churchill, Eimer & Amend Co., discussed briefly "Vicosity." Moving pictures on "The Making of Steel" completed the program. The Chemical laboratory of Connecticut College for Women was visited by those who did not have to leave town by train.

University of Nevada. Sigma Sigma Kappa the local chemistry honor society at the University of Nevada has taken upon itself a new activity this year in the form of a chemical literature club which meets each week for the discussion of current chemical topics. While some of the discussions have been given by members of the chemical staff and of the local station of the Bureau of Mines, most of the reviews have been made by the students. Once each month the program is given a more general character for the special benefit of underclassmen interested in chemistry. The subjects to be discussed are announced each week in the student paper and a general invitation given to those interested. The experiment has been the means of markedly increasing interest in chemistry among the students in addition to filling a long felt need on the part of advanced students.

Recent Books

Laboratory Manual of Chemistry. By GEORGE HOWARD BRUCE. World Book Co., Yonkers-on-Hudson, N. Y., 1924.

This is one of the many loose leaf Chemistry note books and laboratory manuals which have been published in recent months. The sheets measure 8 by $10^1/_2$ inches and are punched to fit the regular covers generally used by students and also to enable the pupil to write up the experiment on ordinary paper following the method of the individual instructor. The loose leaf feature enables the teacher to use his own order of experiments or follow that of any textbook.

The author states in the introduction, "In preparing this laboratory manual the point of the student has always been kept in mind. The author has tried to state the directions as definitely as possible and to refrain from using expressions which are difficult for the average secondary school pupil to understand. Frequently that which is perfectly clear to the instructor is quite beyond the comprehension of the average boy and girl. The aim has been to make the directions so clear that the instructor will not have to spend valuable time interpreting the experiments, but can give his entire attention to observing the work of the students."

The book as a general thing follows the true laboratory method and endeavors to make the student observe exactly and draw the correct conclusion by numerous questions. One particularly desirable feature is the request for EQUATION after each chemical reaction printed in bold face type. In the opinion of the reviewer this is one of the best in its class and will repay any teacher for its examination.

SANFORD SWEET

Colloid Chemistry. By JEROME ALEXANDER. 2nd edition. 208 pages. D. Van Nostrand Co., New York, 1924.

This little book is not a systematic introduction to the subject for the general discussion of colloidal principles is very brief. It is, however, a useful outline of the many applications of colloid chemistry. One could wish that fewer subjects had been treated with more pages, instead of fractions of pages, for each. And it seems unfortunate that all reference to Bingham's work on plasticity should have been omitted.

However, the author is frequently clever and entertaining. The section on soaps is well handled, touching on the classical views of Merklen as well as the modern work of McBain and Fisher. Bread is given special attention while the author's special interest in metals and alloys is quite evident. In discussing milk the blame for "sandiness" in ice cream is wrongly attributed to ice crystals instead of to lactose crystals.

On the whole the book is good. That is why it should have been longer.

HARRY N. HOLMES

The Story of Early Chemistry. By JOHN MAXSON STILLMAN. D. Appleton & Co., 1924.

This book will appeal to teachers and advanced students in chemistry. To the former it will give a vast fund of facts usable in the course of their class instruction, while to the latter it offers source material for their more exhaustive study. In short, it is supplementary in character and construction, as well as in contents, to most of the more recent volumes relating to the history of chemistry. The writer is quite sure that if read and discussed at length in chemical seminars it will be declared to be admirable.

But, it lacks that personal touch which to the writer means so much in all chemical instruction. In a dignified composition, such as this publication, however, it might seem a bit strange, or out of place, to bring in the personal element, which recalls that on one occasion when in conversation with "Billy" Mason (you all know that superb teacher up at Troy), the writer timidly ventured to narrate how he taught qualitative analysis—throwing in all sorts of illustrations to elucidate his various problems—when the dignified Sir William P. smilingly remarked, "But you wouldn't dare put all that into a book which you might write on the fascinating subject of Qualitative Analysis." The writer was humbled and subdued, yet he couldn't rid himself of the ever recurring thought, "Why Not?"

We welcome this excellent book. We mourn the passing away of its distinguished author.

EDGAR F. SMITH